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A PLANTSMAN'S DETECTIVE STORY

FRONTISPIECE. In Japan the skin of an orange called the *Yuzu* is widely used as a seasoning for cooked foods, and the extracted juice serves as a condiment, much as we use vinegar. The *Yuzu* is found semi-wild in southern Japan, and was long supposed to have been indigenous to that region.

Among the many plants discovered by Frank Meyer in China was a wild orange which he called the *Kansu orange*, after the province of Central China in which it was found. Plants of this orange were raised in the greenhouses of the United States Department of Agriculture at Washington, and they were found to be surprisingly like the plants of the *Yuzu* growing there. Examination of Meyer's photographs and botanic material revealed the interesting fact that the *Yuzu* and the *Kansu orange* were identical, thus establishing the interesting fact that this useful Japanese fruit had been imported from China a great many years ago.

This is the field photograph made by Meyer of the fruit of the *Kansu orange*. (See text, p. 245.)

CITRUS FRUITS OF JAPAN

With Notes on Their History and the Origin of Varieties through Bud Variation[1]

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WHEN the citrus fruits of Japan are discussed, attention should be called to the fact that orange culture is one of the leading industries of my country, producing fruit of excellent quality and delicious flavor, with an annual return of more than fifteen million dollars. Other fruits, like persimmons, plums, apples, peaches, sandpears, and cherries are cultivated extensively, but none of them rivals the orange, thanks to the climatic conditions of the island, which throughout a large part of central and southern Japan seem more favorable to orange culture than to any other fruit industry.

In consequence of the utilization of flat areas for rice plantations, oranges are mostly planted on the slopes of hills, the sides of which are terraced on a great scale, using heavy stone walls to retain the soil.

The operations of planting, cultivation, fertilization, picking, hauling, and packing, are all carried on by hand, without the aid of heavy machinery. The fruits are shipped to markets and to centers of distribution by railway or by boat.

Systematic methods of selling have developed in recent years in many regions, and large packing houses and storage plants are constructed either by individuals or by cooperative associations of farmers. Within recent years the exportation of citrus fruits to the United States and Canada has been carried on under strict Government inspection, with every precaution against the dissemination of injurious insects and fungus diseases; but owing to our own excellent home market, the export trade has not developed into an important enterprise.

THE SATSUMA ORANGE

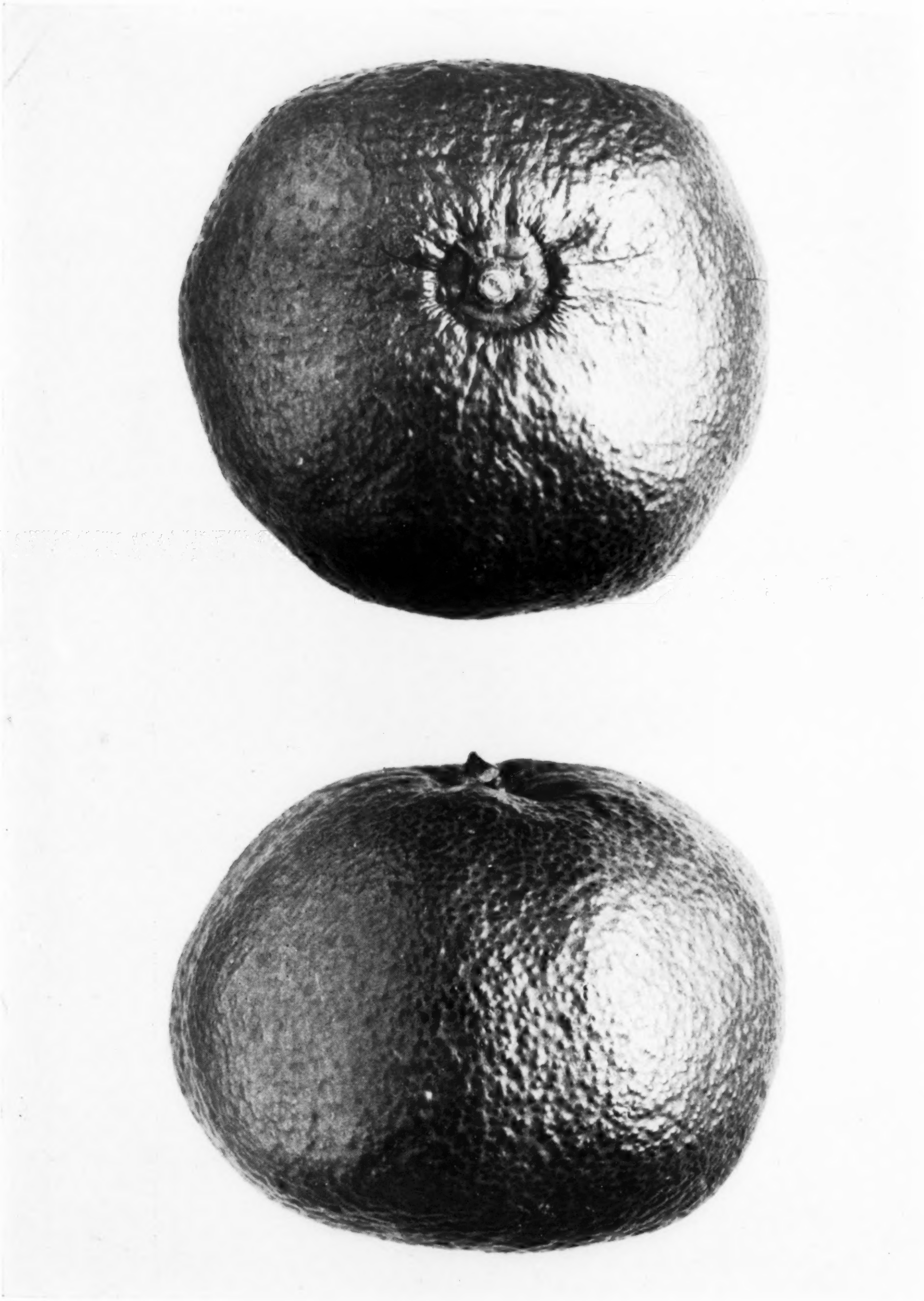
The leading orange grown in Japan is a kind of mandarin, *Unshû Mikan*, called the Satsuma orange in the United States. This variety forms nearly seven-tenths of our entire orange crop. The fruit of the Satsuma differs from the King orange in its soft, thin, rind of a bright orange color, and in its extremely sweet pulp. The leaves of the Satsuma are very large and drooping, with the petiole devoid of conspicuous marginal wings. From common tangerines the Satsuma orange is easily distinguished by the absence of the scarlet or vermillion tinge which characterizes the rind of the tangerines. The Satsuma also is distinguished by the well developed calyx-lobes of its flowers and in its very fine-grained, melting pulp, which is of good keeping quality.

This orange is now raised in the United States, principally in Alabama and other Gulf States, the Satsuma orchards in the Mobile Bay District alone covering an area of about 12,000 acres. Its future is highly promising, owing to the favorable climatic conditions of the region into which it has been introduced, and also to the existence of well organized business methods for handling the fruit. To the more efficient development of the Satsuma orange industry in this country the Office of Crop Physiology and Breeding Investigations is now directing some attention, endeavoring especially to introduce improved strains of varieties into actual cultivation.

NATSU-DAIDAI, A LARGE SUMMER ORANGE

The second important orange of Japan is the *Natsu-daidai*. This is a

[1] Read before the 160th Regular Meeting of the Botanical Society of Washington, at the Cosmos Club, May 2, 1922.



FRUITS OF THE WASÉ ORANGE

FIGURE 1. Theseoranges were bought in the Kobi market, Japan, on the third of November, 1919. They were forwarded to Washington where they arrived December the fifth, and this photograph was taken one month later. This was at least two months after they had been picked, during which time they had been shipped half way around the globe. The fine condition they were still in when photographed testifies to the remarkable keeping qualities of this variety. (See text, p. 251.) Photograph by E. L. Crandall.

large summer orange about the size and shape of a grapefruit; but it differs from the grapefruit in its more pitted skin, which is of a deep lemon-yellow, and in its coarse-grained, slightly bitter pulp, which matures in late spring. It is inferior in quality to a good grapefruit, but its extremely hardy nature and its resistance to citrus canker are appreciated by growers, as well as its admirable sturdiness which enables it to withstand rough treatment.

THE WASHINGTON NAVEL ORANGE

The third important variety of orange is the Washington navel orange which was first imported into Japan in 1891. It was absolutely new to the Japanese growers when it was first introduced, and much attention has been paid to the development of the navel orange industry, but owing to the humid atmosphere and lower temperature, it was found not to do so well as in southern California. Recently Japanese farmers have learned a special method of treating the plant, which checks its vegetative overgrowth and increases fruiting by means of severe pruning or dwarfing, like the treatment of lemon trees in Italy. The good keeping quality of the fruit made it especially desirable, and the Japanese were loath to give up its cultivation.

Other kinds of sweet oranges are plentifully produced in the southern part of the Kyûshû Island; but they do not reach the central markets, from which native pummelos and shaddocks are also absent. Over two hundred varieties of sweet oranges and pummelos are estimated to exist in Japan proper, and a number of promising shaddocks, like *Hirado*, *Egami*, or *Ogami*, are of sufficient importance to be multiplied for economic cultivation. A very prolific mandarin called *Yatsushiro* is often found in cultivation and the common China mandarin, called *Kishû Mikan*, or *Kinokuni* in this country, is more or less extensively grown. *Kunembo*, a variety of the King orange, is also commonly raised in southern provinces.

Besides these well-known kinds of oranges, a number of local varieties or fancy fruits are to be noticed, for instance *Anado* and *Tengu*, attractive for its red skin, but with rather insipid soft pulp; *Naruto* and *Sambô*, yellow skin oranges of late maturing, with good flavor; *Koji*, and *Suruga-yukô*, very early maturing small fruits of extremely smooth surface; *Keraji Mikan* of Kikai island, with very early maturing and extremely fragrant yellow fruit, *Hyûga Natsumikan*, with very late-maturing and very juicy medium-sized fruits.

A MYSTERY SOLVED THROUGH A PLANT INTRODUCTION

Mention should be made of an orange highly esteemed for seasoning cooked food, that is *Yuzu*, first called *Citrus Jonos*, by Siebold, in his *Synopsis Plantarum Oeconomicarum*, published in 1830. This plant grows semi-wild, in southern Japan, but is commonly planted in the yards of farm houses for its fruit. The peel is highly aromatic, and for flavoring cooked dishes and soup or fish it is superior to lemons or limes. The juice is used extensively in the place of vinegar for seasoning raw food and salads. Two hybrid varieties of *Yuzu*, *Yukô* and *Sudachi*, are extensively cultivated in Shikoku Island for vinegar substitutes and also for manufacturing citric acid.

In 1915, Frank N. Meyer, the great agricultural explorer of the U. S. Dept. of Agriculture, found a wild orange in Kansu, China, which he imported into this country under the provisional name "Kansu Orange." After a close comparison of a green house plant of the Kansu orange with the *Yuzu*, together with an examination of Meyer's photographs and notes, the writer found the two to be identical, thereby proving this extremely useful orange to be of Chinese origin.

The seeds of *Yuzu* are sometimes used for raising stock plants for the Satsuma orange, and it is believed by the farmers that plants grafted on *Yuzu* stock live longer and behave better than those grafted on Trifoliate

orange under certain local conditions, especially on hill-top situations where the available surface soil is apt to be very thin.

STOCK PLANTS

For stock plants, Japanese growers use the trifoliate orange almost exclusively, on account of its hardiness and the cheapness of the seed, for this species is extensively planted in hedges surrounding houses. Owing, however, to its high susceptibility to citrus canker, the farmers are having recourse to other species as stock for grafting navel oranges and other varieties of sweet oranges. The sour orange, or Seville orange, is also grown for its juice and seeds. It furnishes a vinegar substitute, not as good as the juice of the *Yuzu*.

A half-wild pummelo, *Yama-mikan*, resembling grapefruit more than anything else, is also used as stock in the southern part of Kyûshû island, like pummelo stock in this country. Recently experiments have been made with Rusk citrange at stations cooperating with the U. S. Department of Agriculture. This stock, it is hoped, will bring considerable improvement in the propagation of orange trees in Japan.

THE KUMQUAT

For preserved or ornamental fruit the kumquat is grown in various localities. This is a small fruit with sweet peel and a pleasantly acid pulp. It occurs in several varieties or forms, such as the *Marumi*, or round kumquat, the *Nagami*, or oval kumquat, and the *Meiwa*, or large round kumquat. Besides the kumquat the thick rind of pummelos is also preserved in sugar, making an excellent candy with a flavor of its own. Sliced Satsuma fruits candied in sugar are also extensively manufactured in southern countries. They make an attractive sweetmeat with a delicious flavor. The dried peel is also used in the preparation of various kinds of drugs. Orange peel and persimmon calyces are the source of a celebrated tonic pill, extensively manufactured by proprietary medicine corporations and conspicuously advertised on signboards throughout the Orient.

AN EARLY AGRICULTURAL EXPLORER

Having enumerated the principal citrus fruits grown in Japan, I turn now to the question of how this remarkably large number of varieties were introduced into actual cultivation. The first citrus fruits introduced into Japan came from China or from some other country of southern Asia. We have two historical accounts of their introduction. The most reliable, written in the Kojiki, or Record, compiled by Ono Yasumaro about 712 A. D., tells of the famous expedition of Taji Mamori, who was sent abroad by the Emperor Suinin in the year 61 A. D. and returned to Japan after an absence of ten years, bringing back eight leafy branches and eight leafless branches of citrus fruits. When he arrived at the imperial court he found that the Emperor was no longer living, and in his grief he took his own life, after having presented at the Emperor's tomb the fruits of his travels which he had hoped to lay at his Sovereign's feet.

Nothing is known of Taji Mamori's itinerary during his ten years of wandering in southern Asia, and the account of the fruit he brought back with him is obscure. According to the Nippongi, a chronicle compiled by Toneri Shinno in the year 720 A. D., the orange introduced by him was the *Tachibana*, the name of which was supposed to be a modification of *Tajima-na*, signifying "Named after Tajima." This explanation, however, is hardly possible; for the *Tachibana*, now occasionally seen as a sacred plant in the court yards of Shinto shrines, grows spontaneously and abundantly in southern Japan, where it appears to be indigenous. The fruit of the *Tachibana* is insignificant from an economic point of view, and the tree is of no importance except for the ornamental value of its small bright yellow fruit, which is too acid to be used for

food. The primeval forest of *Tachibana* found at Tsuro-mura, in the country of Aki, prefecture of Kôchi, has been officially registered as a Natural Monument Reservation of Japan. The *Tachibana* orange grows wild in great abundance not only in the prefecture of Kôchi but also in the province of Hyuga, and a locality named after the *Tachibana* appears in the earliest mythology of Japan.[2]

THE TACHIBANA

The handsome fruit of the *Tachibana* orange and its fragrant blossoms have for centuries been celebrated in poems by the Japanese, in whose coats of arms they also appear. Some of these poems are given in the *Mannyôshû*, or "Myriad Leaf Collection," a most brilliant relic of the ancient people of Japan, compiled about the year 750 A. D. It might be interesting to quote the following poems, in which so many centuries ago the *Tachibana* is named. These, like all Japanese poems, are characterized by their brevity. Each poem is a single thought embodied in a certain number of lines each composed of a definite number of syllables.

Wagimogo ga yado no Tachibana ito chikaku
Ueteshi yue ni narazuba yamaji.

This may be rendered as follows:

My lady's cottage very near
I set a Tachibana tree,
That its bright fruits from year to year
Might tell her of my constancy.

Another poem pictures the *Tachibana* in bloom:

Waga yado no hana Tachibana ni Hototogisu
Ima koso nakame tomo ni aerutoki.

Oh Cukoo, in my blooming Tachibana tree,
Sing loud with joy! My friend has come to me.

Flowers and fruits were formerly strung into garlands and necklaces by the ancient Japanese, as they still are strung by the Hawaiians of the present day. This ancient custom in connection with the fragrant blossoms and golden fruits of the *Tachibana* is commemorated in the following verses, written in the eighth century of the Christian era, when the Anglo-Saxons were still pagans and European literature was at its lowest ebb.

Satsuki no hana Tachibana wo kimi ga tame
Tama ni koso nuke chiramaku oshimi.

May offers thee fair Tachibana flowers,
Like beads to string into a garland sweet.
Oh hasten, lest the fleeting hours
May strew them withered at thy feet.

-oOo-

Waga yado no hana Tachibana no itsunikamo
Tama ni nukubeku sono mi narinam.

My Tachibana's fragrant flowers of spring
Caressed by summer's fervid, quickening air
Have borne fair fruits, like beads of gold, to string
In necklaces to grace my lady fair.

These ancient verses show that the *Tachibana* is not an imported plant, but one that has grown in Japan for many centuries. The identity of the citrus fruit introduced by Taji Mamori still remains in doubt. That he did bring a foreign plant into the Island Empire about the year 70 of the Christian era can hardly be questioned; for the incidents of his celebrated expedition and his tragic death form one of the most important chapters of the Chronicle handed down to us. This early account of an agricultural explorer sent on a mission for the purpose of discovering and bringing back desirable plants to his native country deserves to rank with that of the Queen Hatshepsut's expedition of

[2] In the account of the Creation, Izanagi, the Adam of Japan, had become separated from Izanami, his Eve, and sought her in every corner of the world. At last he went to the land of Darkness, where he found her indeed, not in the perfection of her loveliness, but in the form of a repulsive corpse, whose touch was pollution. He could not conceal his horror on beholding her, and in her fury she called upon the devils of Hell to expel him. On coming forth into the land of Light, the first act of Izanagi was to purify his body at a place, which the myth calls *Tachibana no Odo*, in the province of Hyûga. On washing his right eye a god was born, *Tsukiyomi-no-mikoto*, the Moon God. On washing his left eye, behold a bright aurora emanated from it; this was *Amaterasu*, the Sun Goddess, the first Ancestor of the people of Nippon. Thus is the name of *Tachibana* associated with the very beginning of our race.

1570 B. C., recorded in the hieroglyphics of Egypt and that of Chan Ch'ien, who imported alfalfa and the grape into China about the year 126 B. C. To these early explorers the agents of our own Office of Foreign Seed and Plant Introduction are worthy successors.

About twenty years ago relics of an ancient shrine dedicated to Taji Mamori were discovered in the village of Kamo-mura, county of Kaisô, province of Wakayama. Thanks to the enthusiasm and piety of Toranosuke Mayeyama, a citrus grower of the village, a new shrine was built and several stone monuments were erected on the site of the ancient relics, and recently the village council passed a resolution to establish a new plant-introduction garden and citrus experimental orchard near by, in memory of Tajima's expedition and to emphasize his patriotic spirit to benefit his country through the introduction of desirable foreign plants. It is interesting to see the development of such an idea which had not before been thought of great importance.

Going back to another record of introduction of a citrus fruit into Japan, attention is called to an account in the Shoku Nihongi, or Supplementary Chronicle, completed in the year 797 A. D. under the supervision of the Emperor Kwanmu, stating that in 725 A. D. the Emperor Shômu bestowed upon Harima no Otoe the Fifth lower junior rank of the Imperial Court on account of his successful importation of citrus fruits from China and the propagation of these plants in Japan. The name of the orange alluded to was written in Chinese *Kan ts'u* which corresponds to the *Kinokuni Mikan* now grown in many places.

INTRODUCTION OF THE YUZU

No record of the introduction of the *Yuzu* has been discovered. This name *Yu tz'u* in Chinese is now used exclusively to designate shaddocks in southern China and Formosa. It is not generally used in Chinese for the acid citrus fruit so well known in Japan under this name. In certain old works, however, like *Shuo wên*, the ancient dictionary compiled by Hsü Shen in the first century of the Christian era, and the *Powuchi* ("Record of remarkable objects") written by Chang Hua, who lived 232–300 A.D., there are descriptions of the *Yu tz'u* growing in China, which correspond to the orange with acid pulp which bears this name in Japan. The *Yuzu* plant is fairly well illustrated in the Atlas of *Shao hsing pên ts'ao* or the 1159 edition of the famous *Chêng Lei* herbal, quite lost in China but existing in manuscript copies restored in Japan. In all probability the name was applied to the acid *Yuzu* orange introduced into Japan from China and that the original Chinese name *Yu tz'u* gradually became obsolete in China itself.

THE SWEET KUMQUAT

Concern'ng the introduction into Japan of the sour orange, shaddock, sweet orange, *Kôji*, of the tangerine group called *Beni Mikan* in Japan, and the common kumquat, we have no record. In all probability they came to our shores on board visiting merchant vessels, as in the well-known case of the large round kumquat now called *Fortunella crassifolia* by Swingle. This improved kumquat was accidentally brought to us by a shipwrecked Chinese sailor of Ningpo, cast ashore at Miho, near the port of Shimidzu, Shidsuuoka-ken, where he was rescued by the natives. A preserved kumquat, which the shipwrecked man carried in his pocket, yielded seeds which were planted in a private yard, and which proved to be a type of fruit tree quite new to Japan. This happened during the Meiwa period, that is, between 1764 and 1771, and the Japanese name *Meiwa Kinkan*, or *Neiha Kinkan*, was accordingly applied to this variety. The original parent of the Meiwa kumquats of Japan is still growing in the place where it was first planted.

ORIGIN OF THE SATSUMA ORANGE A MYSTERY

The Satsuma orange, most important of all Japanese citrus fruits, is called

Unshû Mikan in Japan, the orange of Wen Chou, province of Chekian, China. The first valid name applied to this orange was that proposed by Okamura Shoôken in his manuscript work *Keien Kippu* (Monograph of Citrus) written about the year 1828. It gives a good description accompanied by an excellent illustration. The name *Unshû* had before that time been used in earlier works but it had been applied to varieties quite different from the common Satsuma orange. The *Yamato Honzô*, or Japanese Herbal, of Kaibara Ekken, published in 1709, applied the name *Unshû* to a variety with small thin leaves and fruit as large as the *Kino-kuni* Mandarin, with red rind. This description does not accord with the characters of the true Satsuma. In the Japanese-Chinese Cyclopedia, called *Wakan Saisai Dzue*, a work written by Terajima Ryôan and printed in 1714, a citrus fruit called the *Unshû* is mentioned but its leaves are described as resembling those of the *Yuzu* and its fruit, of the size of the *Kino-kuni* mandarin, and as having a thick peel and acid pulp. This description does not apply to the true *Unshû* of Japan. The earliest occurrence of the name *Unshû* in Japanese literature is in a work called *Teikin Orai* ("Family letterwriting") compiled by a Buddhist *bonze* named Gen'e Hôin in the 14th Century. The name also occurs in the *Kagakushû*, a dictionary of primary learning compiled by another *bonze*, Tôruku Hatotsu in 1444, but as there are no descriptions of the fruits mentioned in these works it is impossible to fix their identity. A very old *Unshû*, or Satsuma orange tree, which grew in the small village of Fukutoma-mura, in the prefecture of Fukuoka, died in the spring of 1920. Its age was reputed to be 300 years or more. The oldest living plant which I have seen was one in the prefecture of Oita, growing to a height of 25 feet with its branches spreading over an area of about 40 feet in diameter. It must have been at least 200 years old. The vestiges of a similar tree which had fallen in recent years were also observed. These instances show that the Satsuma orange is a variety which has been known to the Japanese for at least 300 years, although its cultivation on an economic scale was not undertaken until about 40 years ago. It is entirely unknown in China. A local tradition current in the prefecture Fukuoka attributing its origin to the Taikô Korean Expedition of 1592–1597 is in all probability erroneous; since the climate of Korea is too severe for oranges of any kind.

It might be supposed to be of hybrid origin, like many other cultivated fruits, were it not for the fact that the Satsuma has not a single character in common with any other known orange. *Kunembo*, a botanical variety of the King orange, and the *Yatsushiro* are most nearly like the Satsuma in general appearance, but botanically they are quite remote from it. The Satsuma is really a good botanical species, though botanists may hesitate to give it a specific name until the mystery of its origin has been solved. Like maize or Indian corn, its ancestry has not yet been fixed; but it seems advisable to regard it as a distinct horticultural species with a specific name of its own. It seems to me after twelve years' experience with citrus fruits, that the only possible way to treat the group botanically is to regard a number of the distinct forms as horticultural species.

ORIGIN OF NEW TYPES OF CITRUS FRUITS

I come now to the discussion of the origin of new types of citrus fruits. The activities of the Office of Crop Physiology and Breeding Investigations of the United States Department of Agriculture have resulted in the development of thousands of new forms by means of artificial hybridization and selection. It is therefore quite natural to think that hybridization is an important method of obtaining a desirable novelty. Orange hybrids may sometimes lose the parental characters entirely by assuming an intermediate form; but among hundreds of plant characters there must remain some

POT-GROWN PLANT OF WASÉ SATSUMA

FIGURE 2. It is not known how the Japanese Satsuma orange originated, but it has been cultivated for at least three hundred years. Concerning the *Wasé* variety, we know quite definitely that it was discovered about twenty years ago as a bud sport of great promise in a grove of oranges on the Island of Kyûshû. The fruit of the *Wasé* is large and flat and matures much earlier than the other varieties of Satsuma orange. Photograph by E. L. Crandall.

which will behave as Mendelian dominants. For instance, the hairiness of of the ovary, the trifoliate form of the leaves, and the existence of oil in the pulp vesicles are in many cases Mendelian dominants in crosses between the trifoliate and other kinds of oranges. The strong aromatic substance in the rind of the *Yuzu* is also inherited without much reduction by its offspring. Wedge-shaped seeds and the well-developed marginal wings on the petioles of the leaves of pummeloes are also handed down in varying degrees to their descendants, and in addition to these, other dominant characters could be enumerated.

It is difficult, however, to explain the origin of some of the characters which make their appearance, as the absence of seed in the Satsuma and the Washington navel orange. In the flowers of these oranges the male or staminate organs are absolutely abortive, and sometimes the female or pistillate organ lacks the function of fertilization. Vegetative nucellar tissue may develop into the embryo without the intervention of spores. This phenomenon is generally called *apogamy*. The seed thus formed when planted produces a plant exactly like the female parent, whether it has been subjected to cross-pollination or not.[3] A great many plants produce seed by apogamy, and all efforts to obtain hybrids by cross pollinating them are ineffective. Hybridization, therefore, cannot be the only way to create new horticultural varieties. In the Satsuma orange there are several distinct groups or sections, which differ from one another, in some cases by the habit of the tree, in others in the shape and size of the leaves, in others in the time of ripening the fruit, or perhaps in the appearance of the fruit itself.

THE WASÉ SATSUMA

One group, called *Ikeda*, has numerous small leaves and round fruits; another called *Owari*, has larger leaves and flat fruits. From the latter is segregated a strain with very large leaves, and large, flat fruits. This is generally called, by the Japanese *Kairyô*, or improved *Unshû*. Another striking variety, of promising economic value, is the *Wasé*, first found in the village of Aoe on Kyûshû Island, about twenty years ago, and now ranking highest among all the oranges in the market. The discovery of the *Wasé* orange was just an accident, but its development into an important industry was due to the keen business mind of the Japanese farmer. Just how these different varieties originated is not known; but one thing is quite certain, they are not of hybrid origin.

With the encouragement and help of Mr. Walter T. Swingle, I took up the study of citrus fruits in the hope of securing the best type of large-fruiting, early-maturing strains of the Satsuma orange in Japan, which might prove of value to growers in the Gulf states of this country. In the American markets, as everybody knows, fruit is very scarce from October 1st to November 15th; if ordinary varieties of Satsuma are raised, the markets of this season can partly be supplied by fruit from the groves of Alabama. In 1920 the first carload of Satsumas was shipped as early as November 11th. During the last year it was possible to ship this fruit as early as October 23, using artificial methods of curing. There still remains a period of 20 days when oranges are very scarce in the American market. In this connection attention is called to the fact that Japanese citrus growers ship the fruit of *Wasé* oranges as early as September 20.

Wasé is a very distinct fruit, characterized by large round form, extremely thin, polished rind, and very abundant coarsely grained pulp (see Fig. 1). Its leaves, petioles, dormant buds, flower-buds and calyx characters are quite different from all other strains of Satsuma, so that it may well be regarded as a good botanical variety.

[3] SWINGLE, W. T. and T. R. ROBINSON. A New Tangelo. *Journal of Heredity* XII: 151-153, April, 1922.

NEW VARIETIES BY BUD VARIATION

The oldest *Wasé* tree, now about 70 years of age, is found in the village of Aoe, prefecture of Oita. Three younger plants from which the present commercial variety was taken, also exist in the same village. All of them are grafted, and we know not whence they came; but the discovery of almost exactly the same form of orange on a branch of an entirely different kind of Satsuma, threw a new light upon the question of the origin of varieties. In the village of Tsukumi, not far from Aoe, a farmer discovered very early-maturing fruits borne on an ordinary *Owari* Satsuma tree. A careful study of the fruits and flowers of this tree by the writer proved this early variety to be identical in all respects with the *Wasé* originating at Aoe. It was a clear case of progressive or beneficial bud-variation. It is of great interest to note that variations of this kind are by no means very rare; they are, on the contrary, rather to be expected, as a careful study of the phenomenon has shown. In the villages of Hisatomo and Ochô, in the prefecture of Hiroshima, on the inland sea, other strains were found which had likewise originated from bud variation. The characters of the new *Wasé* growing in these places, are slightly different from one another, as well as from the Aoe and Tsukumi *Wasé*. In four different villages of the prefecture of Shidzuoka, I found different strains of *Wasé*, which had undoubtedly originated from bud variations. These bore a general resemblance to one another, but when carefully studied, all of them proved to be distinct. Some of these new varieties have been propagated by grafting and their progenies have, in all cases, been found to possess the new characters without alteration. Commercial orchards of the *Wasé* variety, descended from trees of the village of Aoe, also continue in the main, true to type, but it is especially interesting to note the tendency of the *Wasé* to revert to the parental *Owari* form.[4]

TENDENCY TO REVERT

Early growers of commercial *Wasé* trees noticed that a certain percentage of their plants did not come out as *Wasé*, but reverted to the *Owari* type; and they suspected that there was some mistake made in selecting the budwood. Later it was observed that *Wasé* trees sometimes send forth branches bearing leaves and fruits quite different from those of the typical *Wasé*, but closely resembling the ancestral *Owari* forms. These are clear examples of vegetative reversion, which is known to occur only in a limited number of cases on bud sports, or varieties resulting from mutation. A careful study of this phenomenon convinced me that it is very common in the *Wasé* of Aoe. To cite an extreme case, twenty-seven trees out of one hundred were found to bear branches having the characteristics of the ancestral form on which the variety had appeared as a bud variation. This demonstrates the importance of selecting with the greatest care the buds to be used for propagating.

Whether the *Wasé* is a real somatic mutant or a "chimera" we know not. If a chimera, its reversion to the ancestral form can easily be explained; for most chimeras behave in the same way. At the same time we must expect the occurrence of unchangeable *Wasé* by a similar procedure. We do not know whether or not absolutely constant *Wasé* exists; but of one thing we are quite certain, that bud variation and vegetative reversion are associated phenomena in plants belonging to the genus Citrus, and this may also be true with mutants of other plants not included in the family Rutaceae, though in this connection our knowledge is still scanty. Variegated leaves associated with striped fruits originate by bud variation; and it is well known that in these variegated forms reversion to

[4] TANAKA, T. A New Feature of Bud Variation in Citrus. *Circular 206*, U. S. Department of Agriculture. 1922.

plain color is quite common. Willow-leafed forms associated with elongated fruits also occur from bud variations and often revert to original normal types.

Perhaps the most striking case of vegetative reversion is presented by the corrugated form of *Shûji Mikan*, or Spicy Mandarin, in which two distinct forms of fruit and leaves are always found simultaneously on the same plant. These instances suggest the probability that a closer study of bud sports and sexual mutants will reveal the secret of reversion, the phenomenon opposite to original mutation. Attention is also called to the important rôles which these phenomena may play in the evolution of living organisms, and in the solution of the great problem of the origin of species.

The study of natural phenomena through the behavior of our economic plants is full of interest to the naturalist. The case of the *Wasé* orange is one of the most interesting in this connection, not only to the student bent upon discovering nature's secrets, but also to the horticulturist ready to apply such discoveries to the material advantage of mankind. Nature is always ready to respond to our appreciation and to reward our interest in her laws. It is to the agriculturist that she seems ready to yield her richest treasures.

In conclusion may I quote an ancient Japanese poem which presents this very thought:

"Ametsuchi no Megumi wa tsuneni mujinzô
Kuwa de horitore, Kama de karitore."

which may be rendered in English:

"To mankind boundless wealth is given
By fertile Earth and gracious Heaven.
Then dig ye deep into the mold
And reap your crop of burnished gold."

The Place of Heredity in Biology

FOUNDATIONS OF BIOLOGY, by LORANDE L. WOODRUFF, Professor of Biology in Yale University. Pp. 476, 211 figures. New York, The Macmillan Company. 1922.

It is of genetic interest to find that Professor Woodruff, in putting together what he considers as worth while for "the college student and the general reader" after several years of experience in teaching young men at Yale, has placed unmistakable emphasis upon heredity as one of the important "foundations of biology." This emphasis did not characterize biological textbooks of a generation ago.

The chromosome cycle, mutations, Mendelism, sex-determination, linkage and pure lines are among the many topics that are rescued from the closet of the specialist in this excellent book and made common intellectual property.

The chapter upon "The Heritage of the Individual," in which the task of selecting the important and discarding the irrelevant in the field of heredity has been admirably carried out, closes with the following summary:—"In the first place, it appears clear that the basis of inheritance is in the germinal rather than in the somatic constitution of the individual. A character to be inherited must be innate in the germ cells, and there is no satisfactory evidence that modifications of the body, 'acquired characters,' can be transferred to the germ and so inherited. Secondly, characters or groups of characters are usually, if not universally, inherited as definite units. These follow Mendelian principles of segregation and recombination in the formation of the germ cells of an individual, so that paternal and maternal contributions are readjusted in all the combinations which are mathematically possible. And, finally, the germinal factor basis (genes) of unit characters is remarkably constant. Selection is apparently powerless to alter it, but merely sorts out what is already there, or, taking advantage of such changes (mutations) as do occur, determines their survival value for their possessor in the struggle for existence."

H. E. W.

SUPERBA AND ITS PARENT TYPE

FIGURE 3. *Nephrolepis hirsutula*, of which *superba* is a variety, grows wild only in the Asiatic tropics. Its fronds somewhat resemble those of the sword fern (Fig. 7), but they differ in several respects. The prize for the fern with the most beautiful fronds would undoubtedly go to *N. superba*, the pinnae of which are ruffled and lobed in an exquisite manner. Unfortunately this form and all varieties of *N. hirsutula* can be grown only under the most favorable greenhouse conditions, so that it is entirely unsuitable for cultivation by commercial growers, and by most amateur plant fanciers. (See text, p. 257.)

WHICH BOSTON FERN IS BEST?

PROSPECTUS OF AN EXPERIMENT TO ANSWER THIS QUESTION

R. C. BENEDICT

Brooklyn Botanic Garden, Brooklyn, N. Y.

TO STATE that the Boston fern in its many varieties is the most important of cultivated ferns is a truism. To judge the supreme excellence of one variety is a matter less readily determined. During the eight years in which a scientific study of the varieties of Boston fern has been carried on at the Brooklyn Botanic Garden, the commercial aspects of these ferns have aroused interest. Practically all the named and unnamed varieties of Nephrolepis are under cultivation there; it has therefore been possible to form some general opinions on the qualities of the different kinds.

Within the last year experiments have been undertaken with the aim of determining accurately, by means of test cultures, the relative characteristics of the different commercial forms. For the present, only the once divided or once pinnate forms are under consideration. A test of single plants of about twenty-five different varieties has already been made over a period of six months. These plants were placed in separate compartments of the stock bench in rich soil with good drainage and light. But it is obvious that such a test cannot possibly furnish the basis for the accurate conclusions desired. A second six-month's test is under way but even this will not be adequate for final determinations. The limited space at the Botanic Garden makes it impossible to grow a large enough number either of stock plants or of their progeny in pots. Because of this condition the writer has asked the cooperation of commercial growers, experiment stations, and agricultural colleges in effecting tests sufficiently extensive for obtaining conclusive evidence. To this end arrangements are being made to send sets of small plants of the many varieties to those who will undertake to make careful tests under standardized conditions.

Experimenters generally will be gratified by the results of their investigations. The commercial grower in particular will derive more than one benefit; the varieties in the set will produce salable plants; such a set of different kinds will furnish excellent material for exhibition at flower shows; the knowledge gained will more than compensate for the extra time required to make the necessary observations. Some growers may hold that they already have a knowledge of the cultural qualities of the different kinds of ferns sufficient to their needs, but it is plain that most growers apply their knowledge to a relatively small number of different varieties. More widely disseminated knowledge of existing varieties will avail commercial growers as a group by checking the introduction, as new forms, of varieties already in the trade.

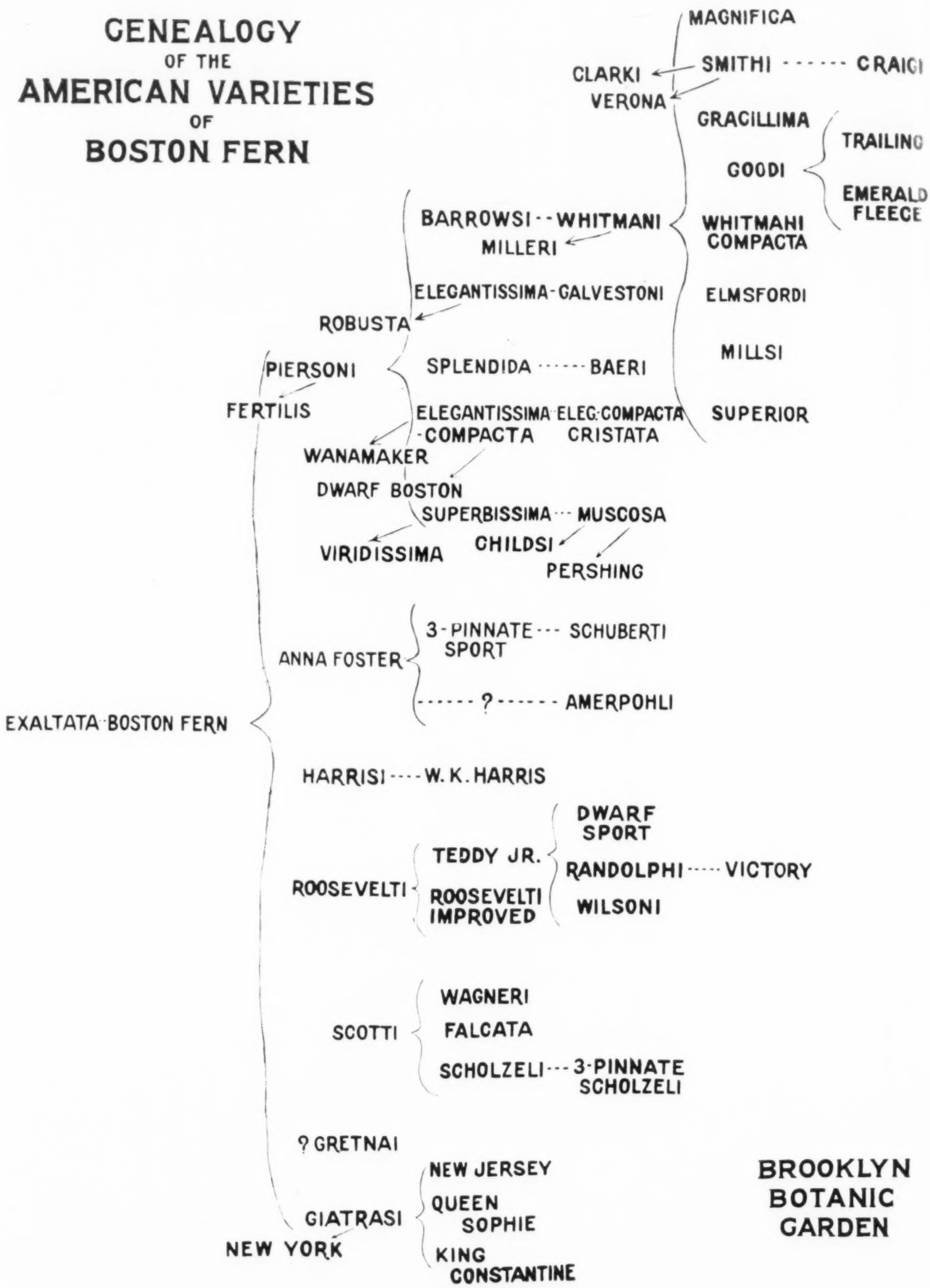
UPON WHAT BASES OF JUDGMENT IS THE BEST FERN TO BE DETERMINED?

In judging ferns for home usage and the purposes of the retail florist, appearance and lasting qualities are probably the most important factors. The commercial grower would also add the cultural characteristics as a third basis. A number of different bases of judgment may be summarized as follows:

(1) Appearance; size; beauty and grace of leaves; color and cutting of leaves; compactness and symmetry of whole plant.

(2) "Hardness" or "softness," i.e., the keeping qualities under the conditions of the home and retail florist shop.

GENEALOGY OF THE AMERICAN VARIETIES OF BOSTON FERN



THE FAMILY TREE OF THE BOSTON FERNS

FIGURE 4. The original Boston fern was discovered about 1895 as a sport from the wild sword fern. Since then nearly two hundred bud variations have been recognized, of which about one hundred have been named. The primary sports of the Boston fern are of four kinds, divided, ruffled, dwarfed, and fish-tail (in which the tip of the pinna is split). These characters are developed to a higher degree in the secondary sports. The arrows indicate a reversion to a simpler type.

A USEFUL FERN FOR BASKET WORK

FIGURE 5. This fern is not in the Boston fern series, but is a separate species, *N. pectinata*. It makes a particularly fine growth for basket work, producing a great profusion of slender, gracefully drooping fronds.

(3) Productivity in runners.
(4) Response after transplanting, that is, slow or quick growth.
(5) Continuity of growth throughout the entire year.
(6) Ease of care. i.e., with overhead watering and so forth.
(7) Special characteristics for special uses, as for basket work.

It may be noted, as suggested above, that there are several different points of view in judging these plants. The mail order florist will have preferences different from those of the jobber; the city retail florists' demands will not be the same as those of the small retail grower with neighborhood customers. The fern specialist will be interested in other characters than the general grower who will want a variety to serve as a rotation crop in connection with various kinds of flowering plants.

CHARACTERISTICS OF INDIVIDUAL VARIETIES

The prize for the most beautiful leaves among Nephrolepis varieties would probably go to N. "superba" (*N. hirsutula superba?*), an English form in which the leaves are ruffled and lobed in exquisite fashion, each having the effect of a graceful plume. (See Fig. 3.) Unfortunately this form and all the several other varieties of *N. hirsutula*, an East Indian species, are culturable only under the best greenhouse conditions, so that this form is not valuable at all for ordinary American commercial growers.

Another Nephrolepis form not in the Boston fern series, but a separate species, *N. pectinata*, which produces a great quantity of slender, graceful, drooping leaves, makes a particularly fine growth for basket work. (Fig. 5.) Although almost unknown in the American trade, it has possibilities of some value for this special work.

There is no question that the varieties derived from *N. exaltata*, the wild parent form of the Boston fern, are the best for all-around use, particularly for home growth. It is unfortunate that definite knowledge of the origin

of the Boston fern itself is not at hand. That it arose from the wild sword fern, *N. exaltata*, (See Fig. 7) can scarcely be doubted. That it is an improvement horticulturally over the wild form is also certain. The cultural excellence of the Boston fern is pronounced. It produces more leaves to a given size pot; the leaves are less stiff, and more graceful; they are less "seedy," that is, less fertile than the wild forms, in which the leaves are heavily laden with the brown fruit dots, and their spore product is deposited upon lower leaves as a disfiguring dust. Furthermore, the Boston fern is quicker in growth and reproduces much more rapidly than the sword fern.

It is interesting to note that even among the wild forms there are variations in growth habits and leaf characters like some of those in the Boston fern series. Two plants of the wild sword fern are shown in Figure 7; both came originally from Florida. They had exactly the same culture in the greenhouse, having been grown side by side, but there are evident differences in the shape of the whole plant, in the length and carriage of individual leaves, and in the conformation of the leaf divisions or pinnae. Ruffling of the leaflets which distinguishes the Harris and Roosevelt varieties of Boston fern also occurs in the wild type. Both plants shown were originally collected in Florida, one by Dr. John K. Small of the New York Botanical Garden; the other was obtained through the Bureau of Plant Industry.

With respect to the other varieties illustrated, attention may be called to the fact that two of these, "Teddy Jr.," and "Randolphi," (Fig. 8) exhibit excellence in the production of numerous leaves to form symmetrical, compact plants. Both are deservedly popular as quick growing types and also because a full-grown plant is smaller in size, and often more convenient for store purposes as well as for the home. Mentioning them in this connection is not in any way an attempt to answer the question asked in the title, but, merely to call attention to certain characteristics that make them especially appropriate for particular uses.

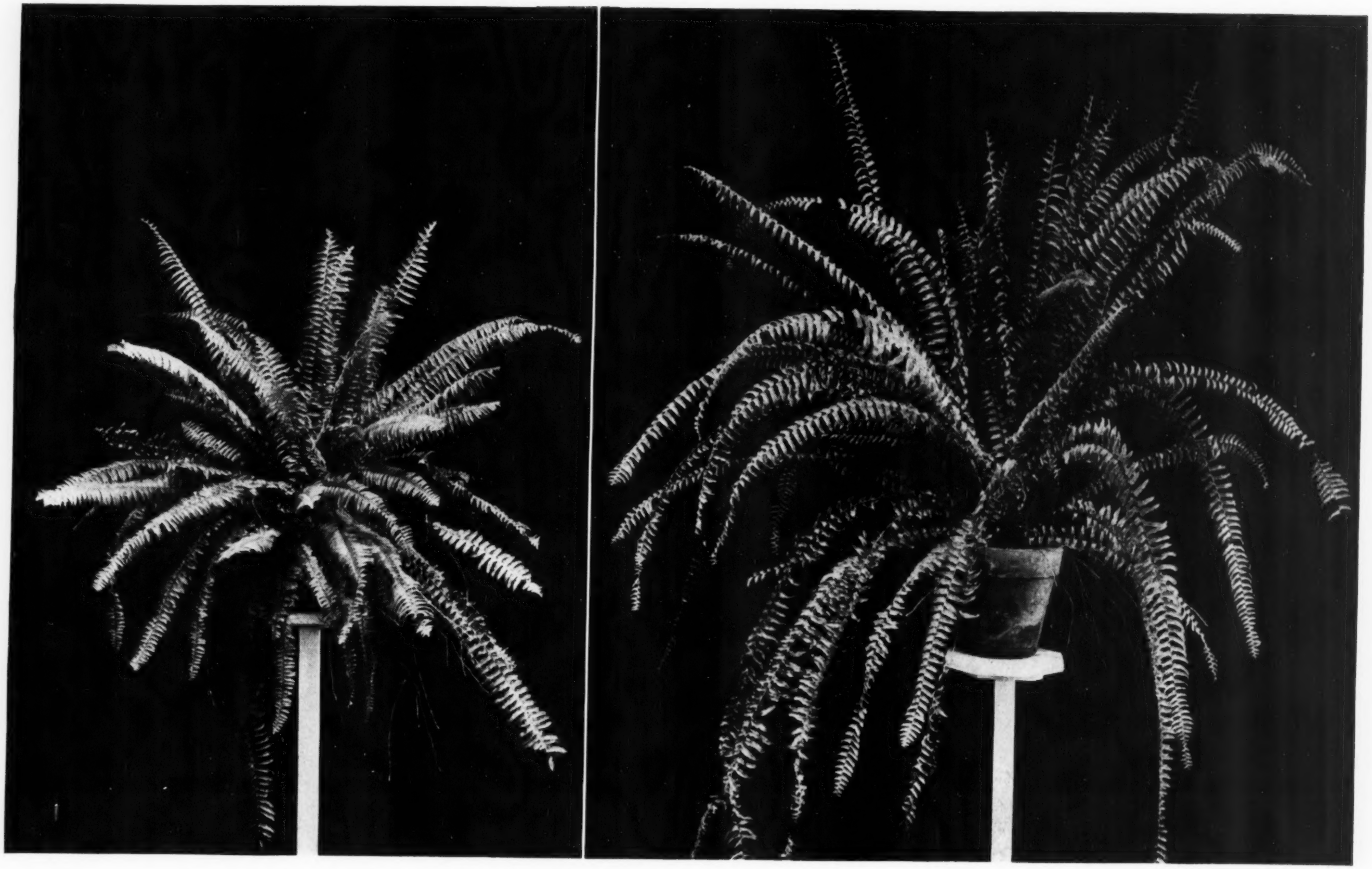
It will be noted that the largest plant, a specimen of the wild sword fern from Florida, shows a spread of leaf of practically six feet, with individual arched leaves four feet long. Leaves of wild plants in Florida have been measured over twenty feet in length. The second plant, called Teddy Jr.,

Ferns included in the present Experiment at the Brooklyn Botanic Garden

Name of Fern	*Home Locality*
Boston	F. C. Becker, Cambridge Mass. & others.
Childsi	J. L. Childs, Floral Park, L. I.
Dreyeri	Dreyer Bros. Whitestone, N. Y.
Dwarf Boston	F. R. Pierson, Tarrytown, N. Y.
Edmonton	H. B. May & Sons, Upper Edmonton, Eng.
Falcata	Peter Wagner, Brooklyn, N. Y. (There is also an English falcata)
Giatras	George Giatras, West Hoboken, N. J.
Gretna	B. M. Wichers & Co., Gretna, La.
Harris	Wm. K. Harris & Co., Philadelphia, Pa.
McCaw	McCaw Bros., Norwood, Pa.
New Jersey	George Giatras, Hoboken, N. J.
New York	George Giatras, West Hoboken, N. J.
Randolph	Randolph & Sons, Verona, Pa.
Roosevelt	American Rose & Plant Co., Springfield, Ohio.
Schubert "dwarf Boston"	Schubert Bros., North Bergen, N. J.
Scott	John Scott estate, Brooklyn, N. Y.
Splendida	Good & Reese Co., Springfield, Ohio.
Sword	Florida (wild)
Teddy, Jr.	Am. Rose & Plant Co., Springfield, Ohio.
Victory	F. R. Pierson, Tarrytown, N. Y.
Viridissima	F. R. Pierson, Tarrytown, N. Y.
Wagner	Peter Wagner, Brooklyn, N. Y.
Wanamaker	Robert Craig, Philadelphia, Pa.

THE BOSTON FERN REPRODUCES ONLY BY RUNNERS

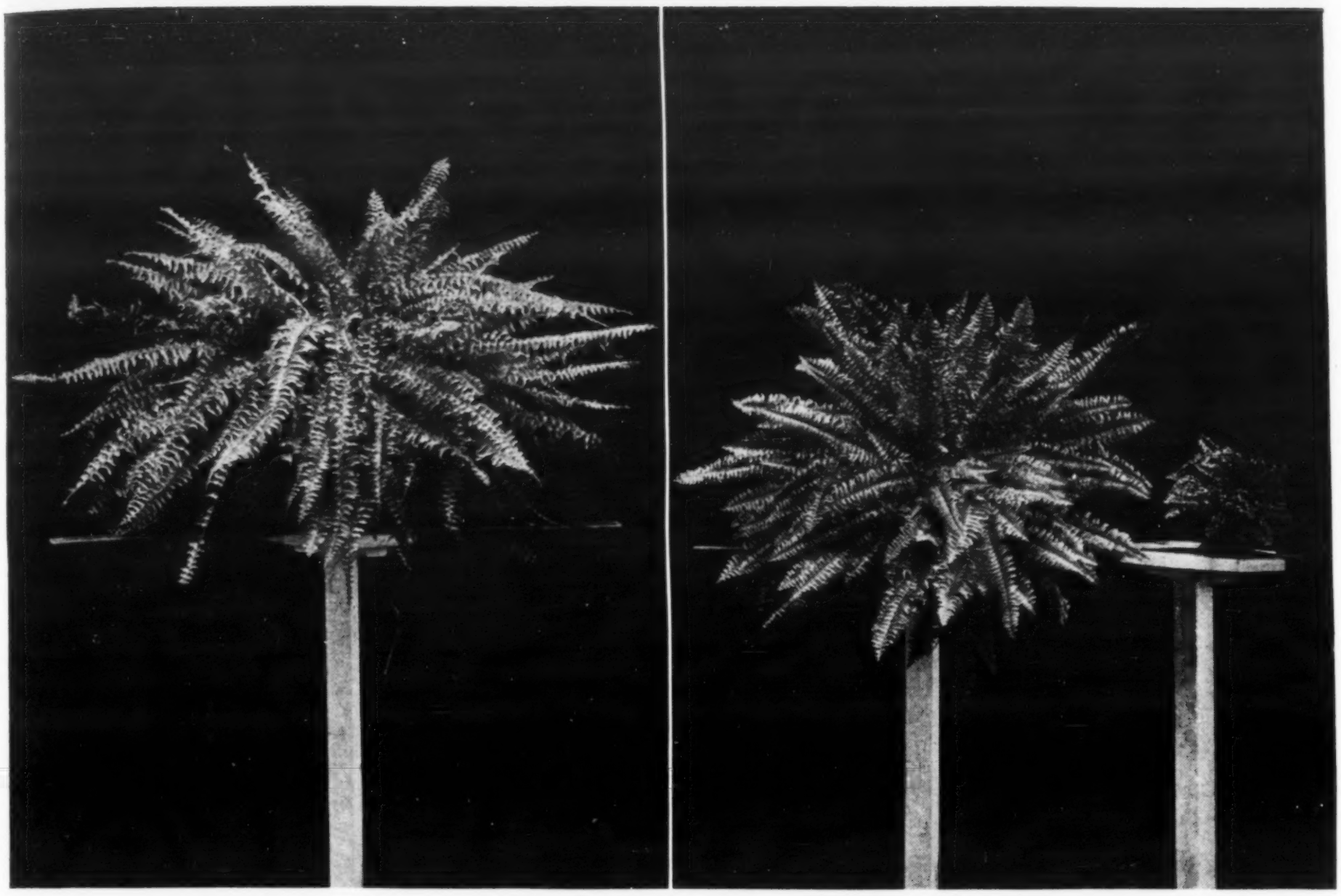
FIGURE 6. Many species of ferns reproduce both by runners and by spores, but the Boston fern produces no spores, so that new varieties arise only as bud variations of the stolons or runners, which are given off in association with each leaf. The stolons bear the roots which supply the main stem and leaves with food, and at intervals they also give rise to new plants by budding. The plant shown is a type of sword fern collected in Porto Rico for the New York Botanical Garden.



WILD SWORD FERNS FROM FLORIDA

FIGURE 7. The smaller one is the typical form, while the other is a variant. The larger plant differs from the normal in other respects than size. The pinnae are set farther apart and are all curved backward with hooking tips. The fronds are also somewhat more curved, but are not so graceful as those of a Boston fern grown under similar conditions.

The sword fern is the progenitor of the Boston fern, which appeared as a bud sport.



A. PROGRESSIVE SERIES OF DWARF VARIETIES

FIGURE 8. This picture and the preceding one are on the same scale. Some forms of the wild sword fern (Figure 7) measure six feet across. The leaves of the different forms are progressively more ruffled and crinkled. Such a series arising in a definite sequence illustrates the orthogenic theory of evolution.

is a direct descendant of the Roosevelt fern, and has all the vigor appropriate to such a name encompassed within a spread of but three feet. The third fern, "Baby Randolph," is also a descendant of Teddy Jr., but still smaller, the last fern in the picture is an unnamed sport of Teddy Jr. Its leaves are less than six inches long, but very much crisped and ruffled, having, as it were, a natural permanent wave.

This variety may practically be counted out of the race at the start. It has attractive leaves, and makes a well-shaped plant, but grows too slowly to be of general value. Although it has appeared as a new form in the greenhouses of several florists, it has never been deemed sufficiently valuable to receive the distinction of a definite name. On the other hand, there are undoubtedly people to whom its dwarf prettiness would have a special attraction.

THE VARIETIES INCLUDED IN THIS TEST

On page 258 is given a list of the varieties included in the experiment at the Brooklyn Botanic Garden. It will be noted that all belong in a single class of the Boston fern group,—i.e., those with the leaves merely once-divided or once pinnate. It is not possible at the present time to include the numerous plume and lace varieties. The number of plants to be tested would then run over one hundred. As a matter of fact, for ordinary growth characteristics, the "plain" Boston fern types undoubtedly surpass the others.

Are there any other entrants? Any omitted names? New ferns may be entered in the competition. If desired, the plants will be received with the understanding that they will be held strictly at the Botanic Garden for comparative growth, and not sent out to any of the other establishments

A HUGE NEPHROLEPIS

FIGURE 9. *N. biserrata* grows wild in Florida and throughout the American tropics, but the ordinary type is not nearly so attractive as this form, the source of which is not definitely known. Grown in a hanging basket it makes a particularly fine conservatory plant.

at which the experimental contest may be held.

TECHNIQUE OF THE EXPERIMENT

In carrying out the experiment it is necessary to observe considerable care in growing the different varieties to avoid possible mixing. This is due to the fact that these plants reproduce by means of long slender runners or stolons (See Figure 6). The latter vary in length and vigor of growth in different varieties. In some types they may penetrate the soil or run along the surface five or six feet in various directions, taking root occasionally and producing scattered bud plants as outgrowths from the runner. Even in the less vigorous, smaller varieties, these runners may penetrate the soil for considerable distance in all directions, so that it is necessary in growing a series of different kinds in proximity to each other to take particular pains to avoid mixing. The suggestions outlined below cover methods aimed to keep the different varieties distinct.

(1) Separate the different kinds to avoid mixing; runners will mix six inches and more deep.
(2) Plant unlike kinds together so that mixing may be easier to detect.
(3) Lift runners and stock plants very carefully, so that the connections may be traced to the mother plant.
(4) Small varieties may be stocked in large flats if other conditions are kept uniform.
(5) Plants should be kept labeled and, in addition, a record of the position in the bench should be kept.
(6) Determine productivity by a careful count of all runners large

enough to grow after a six months period.

(7) Continue productivity test a second six months to determine whether different varieties are equally good throughout the year.

(8) Raise all runner progeny under uniform conditions, which are probably most certainly secured in pots.

(9) Label all potted runners or keep the pots together in flats and label one or more in each flat.

(10) Keep similar types separate to avoid danger of mixing pot plants.

(11) For productivity tests, select single plants of as near the same condition of growth, number of leaves, stolons, habits, color, freshness, etc., as possible. At the start of the first six months test, uniform runners may be difficult to obtain but for the second six months, the new stock plants can be taken directly from the old bench.

As a supplement to the test it is hoped that arrangements may be made to establish competitive classes at flower and plant shows as they are held in the course of the next year and afterward. Such classes might well include the following:

1. Best single specimen plant of any Boston fern variety.
2. Best group of ten plants of any single variety as grown for the trade.
3. Best ten plants of any dwarf variety in three inch pots.
4. Best collection,—single plants,—of ten or more distinct once-divided Boston fern varieties.
5. Variety with the most beautiful leaves.
6. Best single basket plant grown as exhibited.

Are there any other important items that have been overlooked? Are there any recognized published standards for judging specimen plants like those used at exhibitions? Should there be separate classes specifying the conditions of growth? Suggestions and cooperation in conducting this competition are earnestly desired.

THE HOME OF THE INDO-EUROPEANS, by Harold H. Bender, Professor of Indo-Germanic Philology in Princeton University. Pp. 57. Princeton Univ. Press, Princeton, N. J., 1922.

We are wont to look for information about past ages and peoples to museums where are displayed the findings of archeologists and anthropologists. Occasionally we are led from the familiar path by the fire of a new idea that takes us through ways less trodden but no less inviting. Such is the case when Professor Bender directs us by the road of philology to the probable home of the Indo-Europeans.

Language is one of man's greatest gifts, and his utilization of it makes it possible for us to learn something of man himself. The discovery of the relationship of most of the languages of Europe with one another and with those of India and Persia, and recognition of their common ancestry from a prehistoric tongue, was an important one in evolutionary science. Since this discovery the question of the original home of the Indo-Europeans, who spoke this ancestral language, has been a problem to attract countless philologists, archeologists, and anthropologists. Professor Bender believes the solution is to be indicated by linguistic science.

Approaching the problem by the route of modern philological research, Professor Bender reaches the detached attitude of science and employs the process of elimination. The presence or absence of words in the Indo-European languages allow and cause the elimination of certain geographical sections, at one time or another believed to be the home of the Indo-Europeans. The prevalence in almost every Indo-European language of a word for honey or for an intoxicating drink made from honey shows that the primitive home of the Indo-Europeans must have been a honey-land. Again, names of flora and fauna existing in these languages
of the climatic conditions in the home of the Indo-Europeans. The cumulative evidence drawn from vocabulary makes the position that the home of the Indo-Europeans was southeastern Europe appear tenable. The technical apparatus of philology with its division of *centum* and *satem* languages, Grimm's law of consonants, and other precepts, introduces further support for this belief.

Professor Bender anticipates considerations that might be offered as objections. Traditional beliefs are overthrown and these refutations become supporting qualifications in his convincing dialectics. The arguments are so logical, the evidence so decisive, that the reader is satisfied that the plain of eastern central Europe, in which live the Lithuanians, who have preserved more faithfully than any other people on earth the language and cultural position assumed for the prehistoric Indo-Europeans, is the probable ancestral home of the majority of civilized peoples.

Professor Bender does not ignore the contribution of archeology and anthropology to the body of knowledge concerning the Indo-Europeans, but the part of philology's sister sciences is slight in this determination of our heredity. Philology becomes a vital power; archeology and anthropology may be guided by it and their investigations sustain and confirm the position of philology on this question. We are indebted to Professor Bender for the best English presentation of philology's important contribution to the solution of the problem; its services in helping to reconstruct the history of the past determine the place of linguistic science as an efficient ancillary of philosophy in explaining the meaning of the present.

INTELLIGENCE AND RACE

A REVIEW OF SOME OF THE RESULTS OF THE ARMY INTELLIGENCE TESTS

I. Foreign-born

PAUL POPENOE

Coachella, California

OF THE American army raised during the Great War, something like one-sixth was foreign-born. Mental tests, given to nearly 2,000,000 soldiers,[1] bring out some highly interesting and significant differences between these foreign-born and the native-born Americans; and also between various parts of the foreign-born contingent. A few of these findings of particular eugenic interest are noted in the present paper.

For statistical analysis, the psychological members of the Surgeon General's staff who had the work in charge, took a sample of about 94,000 men of the white draft, this being as large a number of records as could be successfully handled with the means at their disposal. Of these 94,000, approximately 13,200 reported that they had been born in a foreign country. Different nations were represented in widely varying degrees, many countries having only a few hundred men in the list, while Russia was responsible for over 2,300 and Italy for more than 4,000.

Figure 11 shows the average mental age of the representatives of each country which had more than 100 men in the sample. For comparison, the graph includes the average of the white officers (who with few exceptions were native-born Americans); the average of the white draft, including the foreign-born section; and, finally, the average of the negro draft, which is almost wholly native-born American.

If a mental age of 20 years be taken as the point attained by a very intelligent adult, and 16 years as the average normal adult of white American stock,[2] the relative standing of the various groups is at once apparent. The officers form a group better than the average, as one would expect, since some mental superiority is necessary to enable one to discharge the duties and responsibilities attached to a commission.

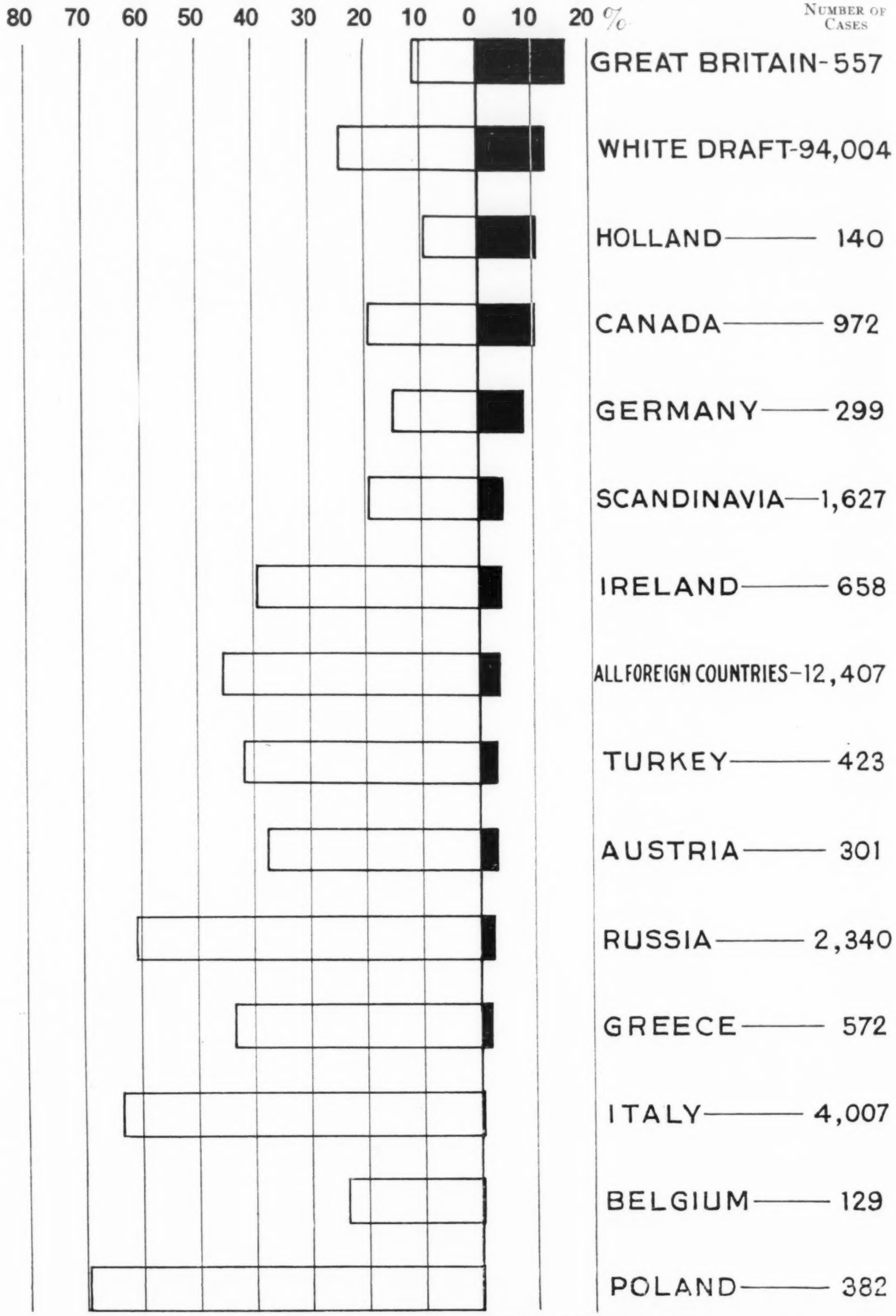
The Canadian contingent probably differs little in racial antecedents from the bulk of the old white American stock; and its average age of 13.29 years is not greatly different from that which the whole white draft would show, if the foreign-born elements were subtracted from it. For the present purpose, it would perhaps not be far from right to class the Canadians as also native-born white Americans—as many of them in fact are.

Passing this group, the average soon begins to decline. Great Britain stands at 13 years—and the inclusion of the Irish in this classification tends to pull down this average, as will appear later. If Ireland were excluded, England and Scotland together would make much the same sort of showing that Canada does.

After the Scandinavian countries and the former "Central Empires," which are but little below the American average, the drop becomes rapid. The young men of Grecian birth measured below the average mentality of a 12-year-old American schoolboy; the larger contingents of Russia and Italy fall still farther, until the Italians are not far above the level (10.37 years) of the American negro, or of a white adult who is of "dull mentality."

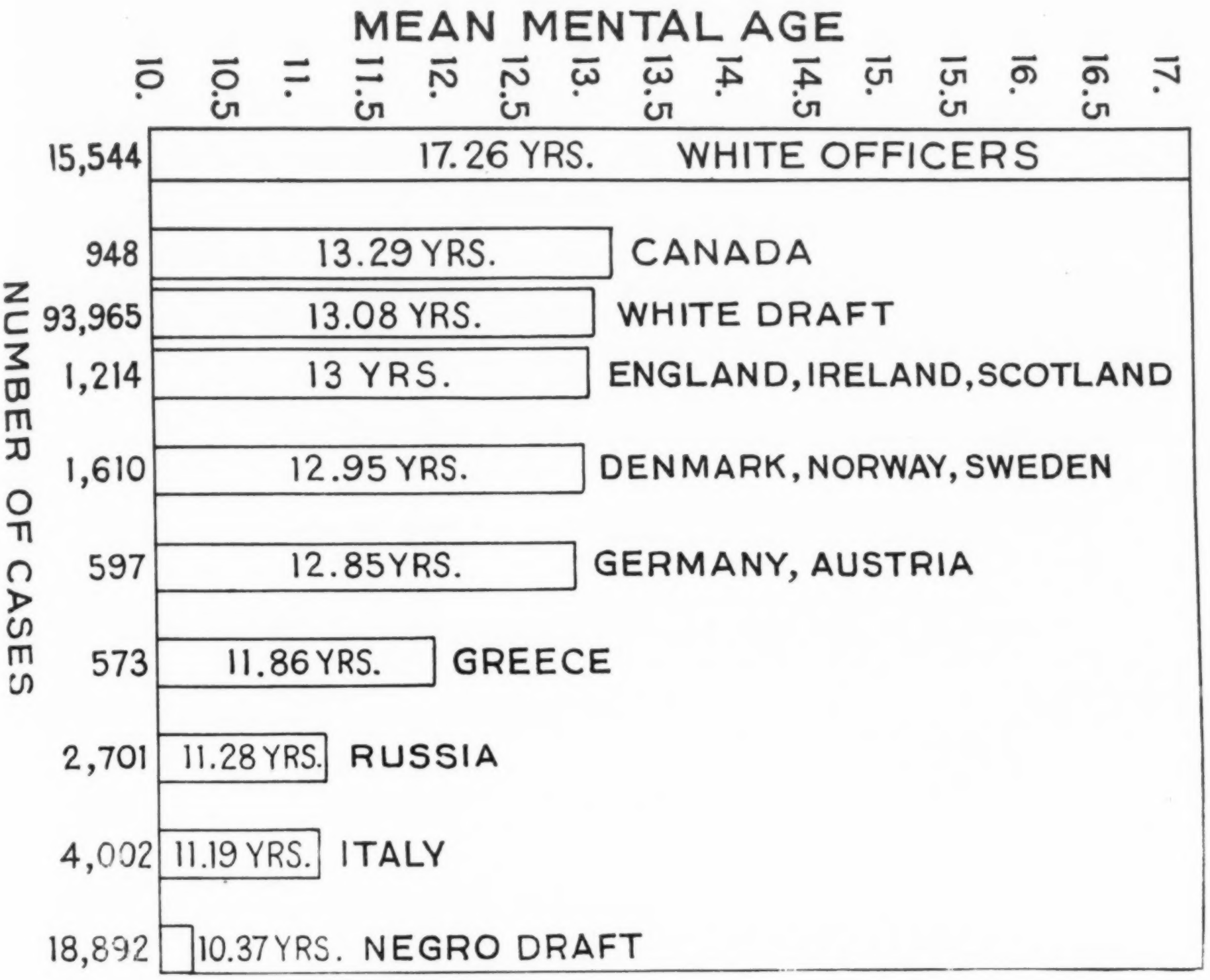
[1] *Mem. Nat. Acad. Sci.* vol. XV, "Psychological Examining in the U. S. Army," ed. by Robert M. Yerkes. Pt. III, Chap. vi and vii. Washington, D. C., 1921.

[2] No particular dependence is placed on these standards, the validity of which has been challenged by various psychologists. They are taken merely for convenience of comparison, since the problem of the foreign born is essentially one of relative values.



THE BEST AND THE WORST OF THE LOT

FIGURE 10. In the above graph, the average age of mentality of the white male population of the United States is taken as zero; columns to the right of this line show the percentage of foreign-born draftees who were found to be above the American average, mentally; while the columns to the left of the line represent the percentage of the foreign born contingent who were below the average white American in intelligence. It is obvious that some of the countries responsible for most of the immigration in recent years are sending men who are almost all of inferior intelligence, as measured by existing American standards.



AVERAGE MENTAL AGES OF DRAFTED SOLDIERS

FIGURE 11. By psychological tests, the "mental age" of a man is measured in comparison with what is assumed to be the normal development of the mind. The above graph shows that, compared with the average (13.08 years) of the whole white draft, many of the men of foreign birth made surprisingly low scores; while the average adult negro showed only the intelligence of the average 10-year old white schoolboy.

These striking racial differences are brought out from a slightly different point of view in Fig. 10. Here the great bulk of the American nation is taken as the standard of division, and the graph shows, to the right of the dividing line, the percentage of soldiers above average mentality, and to the left of the line, those below the average white American mentality.

It is at once obvious that the number of superior men contributed by a country will not furnish a basis for predicting the number of inferiors furnished by that country. There is some correlation, however,—the amount was not measured. From a eugenic point of view, the contribution of superior individuals is in many ways more important to the nation than the number of inferior individuals sent over as immigrants: hence the countries have in this graph been ranked in proportion to the number of individuals of A or B mentality whom they contributed to this sample of the draft.

It is apparent that, aside from English-speaking countries, only Holland and Germany made contributions that averaged fairly well with the bulk of the American population. And worst of all, the proportion of immigrants from these countries during the last quarter of a century has been small. The great bulk of recent immigration to the United States has been made up of Slavic and Mediterranean peoples; and the startlingly inferior quality of these immigrants, from a psychological point of view, has rarely been more strikingly shown

than in these army returns. It is clear, as special students of immigration have long asserted, that the South Italians,[3] Poles, and Russians who have been imported in such large quantities during the past few decades, to furnish American industry with cheap manual labor, represent an extremely inferior racial contribution, measured by existing American standards.

It is not intended to suggest that the immigrants, here described, are fairly representative of their parent populations. It is probable that they are not: but such an admission does not mitigate the seriousness of the situation, eugenically. Whether the United States has become the dumping ground for the representative individuals of an inferior nation, or for the dregs of a superior nation, the effect on this side of the Atlantic is equally unfortunate.

As the figures on which some of these averages are based are small, amounting in the cases of Holland and Belgium to little more than a hundred each, it would be a mistake to lay too much stress on the exact ranking given. But if only the broad general outlines are considered, it cannot be believed that multiplying the data a hundredfold would alter the situation. It is not conceivable that the predominantly Nordic countries, which now stand at the head of the list, would be displaced by the Slavs and Latins who stand so far down at the foot.

It would be interesting to know how far the contingent ascribed to Russia represents Russian Jews. Presumably a large part of it must be made up of the Russian Jewish immigration of the last 30 years. It has often been assumed that the Jews as a race are superior to the average in intelligence. If such an assumption were verifiable in these figures, it would leave the non-Jewish Russians in this contingent in a highly unfavorable light.

Of the foreign-born draftees here studied, approximately 70% had come to the United States within 10 years of registration. When the foreign-born were divided into classes, depending on the length of time they had been in this country, it was found that apparently "the group that has been longer resident in this country does somewhat better in intelligence examinations."

This might be interpreted in a number of ways—evidence on all of them being lacking. It might be that the more intelligent immigrants succeed and therefore remain here while the failures go back home. But since some of the successful immigrants, those who make money, also return home, this hypothesis is uncertain.

Again, it might be that longer residence means greater familiarity with the English language, and hence greater success in the tests. This is largely negatived by the fact that a large proportion of the foreign-born—namely, all those who seemed to require it—were given special tests which were little dependent on the ability to understand English.

Or it may be that the more intelligent young immigrants were those who, in 1914 or shortly thereafter, voluntarily went back to their old homes to answer the call to arms. This may account in some small degree for the observed differences.

But when all considerations are balanced, it seems to me likely *a priori*, that the difference here shown is to a marked extent one of difference in the inherent quality of the immigrants. There are many independent grounds for reaching the conclusion which these figures suggest, that the quality of immigrants to the United States has become poorer, year after year. The first tide of Russian exiles, who came to the "land of the free"

[3] The low standard of recent Italian immigrants, here shown, is not a novel finding: it is confirmed by other investigators. See for example the figures published by A. H. Arlitt (in McDougall, W., *Is America Safe for Democracy?*, pp. 63-4, N. Y., 1921) and by L. M. Terman, in *The Intelligence of School Children*, p. 56, N. Y., 1919. In Miss Arlitt's study, all American school children grouped together gave an I. Q. of 106, while the Italians gave 84 and Negroes (mulattoes?) 83. Dr. Terman's figures are almost identical.

in the '80's, is generally considered to have been better than the average who remained behind. It is not likely that the Russian Jews of 1880–90 could have yielded any such figure as is here shown for Russians of the draft army in general.

Admittedly, the draft figures do not lend themselves in most instances to a detailed and refined analysis. For the present purpose it is not at all necessary that they should. Their general trend is clear, inescapable, and incontrovertible. It shows in a most striking way that the average of American immigrants during the last quarter of a century is below that of the native-born white population; and that the average of the countries which are sending over most of the immigrants, is even lower still. This last average is, indeed, so deplorably low that it is a fair and serious question whether the United States can eugenically afford to admit any more such average immigrants, either without any restriction, or on a percentage basis. Should not the American policy be that of admitting all who are superior to the American average, and no others?

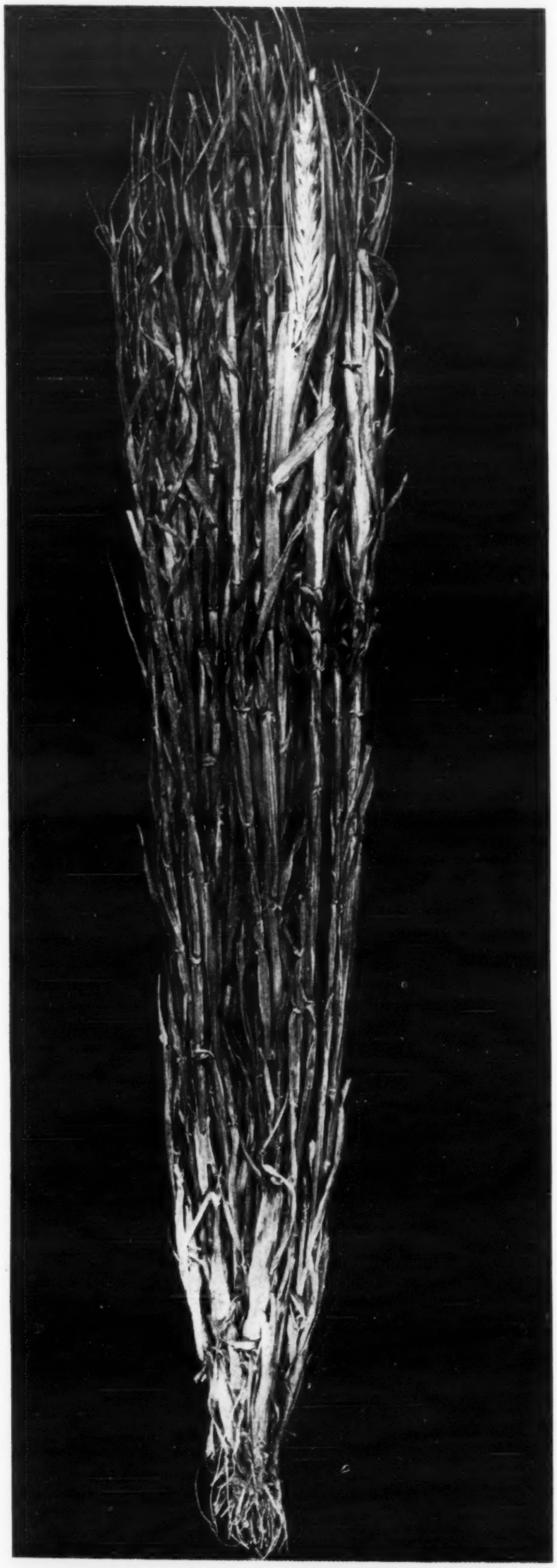
MANY-NODED DWARF BARLEY

HARRY V. HARLAN AND MERRITT N. POPE
Office of Cereal Investigations, U. S. Department of Agriculture, Washington, D. C.

A BARLEY plant having a large number of extremely short internodes and an abundance of fine leaves was found at Aberdeen, Idaho, in the summer of 1918. It occurred in Mesa, C. I. No. 1313, an agricultural variety of *Hordeum distichon nudum*. This plant, which was very short, developed much more slowly than its neighbors, but by August 4 a single fertile slightly modified spike of nearly normal size had emerged, together with about 6 other greatly modified spikes. It was necessary to harvest the plant on this date, although the foliage was still green.

This aberrant plant (Fig. 12) which was grown under irrigation, measures about 50 centimeters from the crown to the tip of the awns. Many of the culms are branched near the base. As nearly as can easily be determined there are 17 culms, divided into 28 branches. In the original plant all the culms have more than the normal number of nodes, and roots are found on the second nodes above the crown. The spike of the original plant shown in Figure 12 is borne upon a culm having about 12 nodes. The internodes, in general, become successively shorter toward the apex of the culm and merge into the rachis of the spike. The three lowest nodes of this spike threw off branches in place of groups of spikelets and the long intervening internodes exhibit the zigzag appearance characteristic of the lower part of the rachis of this strain. The remaining culms have many more nodes, the maximum being at least 20.

In the fall of 1918, one seed was sown in the greenhouse at Arlington Farm at Rosslyn, Va. This germinated and the resulting plant produced a number of greatly modified spikes which, in June, 1919, yielded a few seeds to add to the small original stock. The plant grew very slowly and was much taller than its parent. With the increase in height was an increase in the number of nodes, of which there were 20 to 25 on the average culm. In 1920, plants grown in the greenhouse again were very tall and again produced only greatly modified spikes. Some of the culms reached



THE ORIGINAL DWARF PLANT

FIGURE 12. The dwarf measures about 50 cm. from crown to tip of awns; the parent measures about 95 cm. There are seventeen culms divided into twenty-eight branches. (See text, p. 269.)

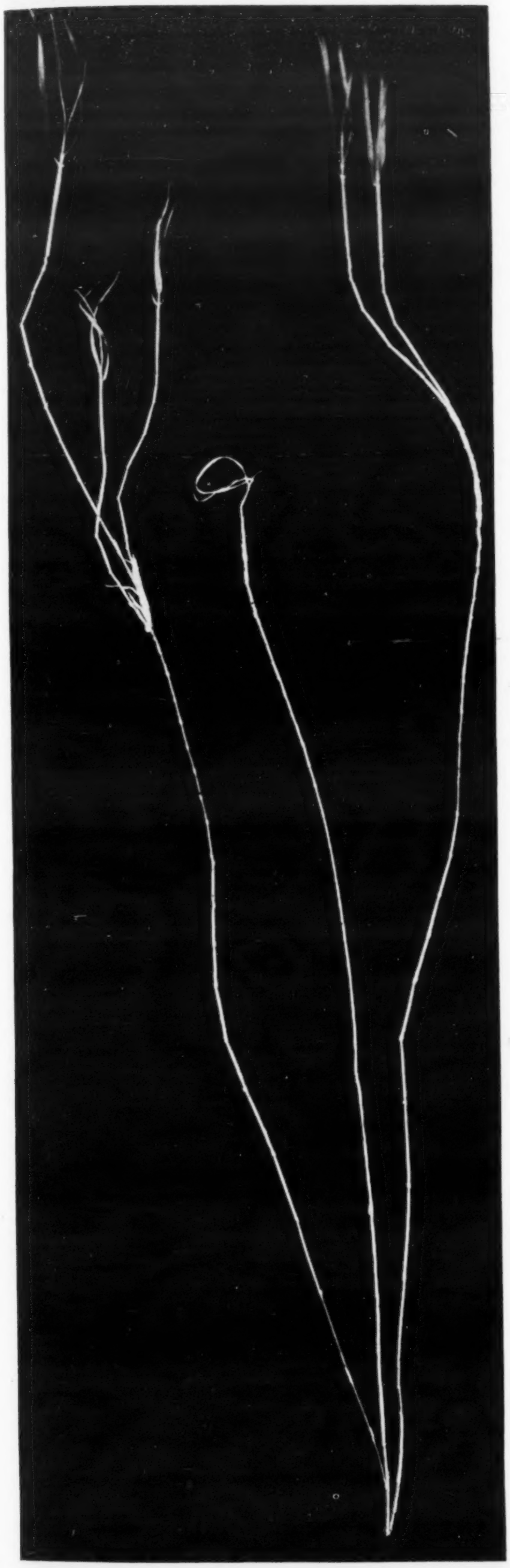
a height of 125 centimeters and possessed over 50 nodes. The greater lengths came from the development of vegetative branches on the inflorescence. These inflorescences often produced no fertile flowers, while frequently one or more vegetative branches at the lower nodes of the modified rachis developed into a culm similar to the original one. There is a gradual transformation of culm to rachis and of vegetative leaves to floral leaves, which it is the intention of the writers to discuss in a later paper.

One of the longer culms is unbranched for 82 centimeters and has internodal lengths ranging from 5 to 7 centimeters near the crown to 1.5 to 2.5 centimeters near the first inflorescence. One of the vegetative branches of this inflorescence is 35 centimeters long and has 29 nodes to the base of the second inflorescence. Many of these vegetative branches remained green and actively growing after the culm below had turned brown. Many attempts at crossing these greenhouse plants were made, but due to the absence of the near-normal spikes on greenhouse plants, little success attended these efforts.

Figure 13 shows a second portion of the plant with the leaves removed to show the branching which sometimes occurs at an inflorescence. Proliferations are to be seen on two of the branches. Figure 14 shows one of the modified spikes from a greenhouse plant.

Two seeds were sown in the nursery at Aberdeen, Idaho, in 1919. Both germinated and produced many-noded plants which again were only about 50 cms. tall. These plants produced many abnormal spikes containing a few seeds and two or three rather small spikes of nearly normal appearance. The culms which bore the more nearly normal spikes had fewer nodes and a much more nearly normal appearance than the others.

At Aberdeen, in 1920, plants of this dwarf form were grown which produced several nearly normal heads, and hybrids with several different varieties of barley were made successfully. In



BRANCHING AT INFLORESCENCE

FIGURE 13. In this case, branches have developed at the inflorescence. These inflorescences often produced no fertile flowers and the vegetative branches often grew to considerable length and remained green long after the remainder of the plant had turned brown.

A MODIFIED SPIKE

FIGURE 14. Great variation in the extent of abnormality of the spikes was found. In the extreme cases branches were given off at the nodes instead of spikelets; others were nearly normal. Very little seed was produced by the greatly modified spikes.

PARENT FORMS AND FIRST GENERATION HYBRIDS WITH THE DWARF BARLEY

FIGURE 15. The two parent forms on the left are Nepal and Manchuria. The type of heads obtained by crossing these two species with the dwarf form are shown on the right. No "dwarf" characteristics are found in the first generation, but in the second generation segregation of normal and dwarf forms occurred in a ratio of approximately three to one, indicating that the dwarf character is a Mendelian recessive.

1921 the Aberdeen "dwarfs" were again typical of the dwarf plants as grown outdoors in summer. One of these had 26 culms about 60 cm. long and having 12–18 nodes, and on the same plant were found 5 culms which seemed normal. None of the latter possessed more than 6 nodes above the crown, the longest was 92 cm. in height, and all five had nearly normal spikes.

The crosses were made in 1920 upon 4 varieties, as shown in Table I.

The crossed seed was grown in the greenhouse at Arlington Farm in the following winter and the F_1 heads shown in Figure 15 were obtained. No "dwarf" characteristics were found in the plants bearing these heads. The F_2 seeds from these heads were sown at Aberdeen in 1921 and produced populations which segregated for type of plant as shown in Table II.

In the Utah Winter cross, the winter plants cannot be accurately classified because of late maturity. Considering the small numbers used, the ratios obtained are in fair accordance with the expectation on a basis of a 3:1 ratio, showing the segregation of a Mendelian recessive.

Few dwarf plants have been reported in barley. Bungo Miyazama[1] reports the finding of dwarf forms in the back-cross upon Golden Melon by an F_1 plant, the offspring of a cross between Golden Melon and the Japanese variety, Sekitori. This dwarf was heterozygous, breaking up into normals of the parental types and a still more dwarfed type in the ratio of 1:2:1. Neither of these dwarfs was at all like the one here discussed. Vestergaard[2] reports finding 3 dwarf-like variants in an otherwise constant line of 2-rowed barley. When crossed with Binder barley, of the 95 individuals, constituting the F_2 progeny, 81 were normal and 14 dwarf, giving a ratio of 6:1. The dwarf is not described.

In February, 1922, Dr. K. F. Kellerman, Associate Chief of the Bureau of Plant Industry, called the attention of the writers to a dwarf form of *Hordeum vulgare pallidum* which he had received from Mr. J. M. Mack of Fallbrook, Cal. Mr. Mack stated that he had discovered the type in a field two years previously. This dwarf is apparently the same type of variation as that found by the writers, but in a 6-rowed hulled barley, while that found at Aberdeen was in a 2-rowed naked barley. The double appearance of this variation seems to have one plausible explanation, namely, that it is a mutation where all the modifications which occur in the plant are caused by the same factor.

Hor[3] describes what is undoubtedly the same barley as that received through Dr. Kellerman.

TABLE I. *Data Regarding Barley Varieties Crossed with the Dwarf Form*

Baku,	*H. dis. nudum*,	2-rowed, bearded, naked (parental type of "dwarf").
Manchuria,	*H. v. pallidum*,	lax 6-rowed, hulled, bearded.
Utah Winter,	*H. v. pallidum pyramidatum*,	very dense, 6-rowed, hulled, bearded, winter habit.
Nepal,	*H. v. trifurcatum*,	6 rowed, naked, hooded.

TABLE II. *Segregation of F_2 Generation of Dwarf Barley Crosses*

Parentage	Normal	Dwarf	Ratio
Dwarf × Baku	45	14	3.21:1
Dwarf × Manchuria	49	17	2.88:1
Dwarf × Utah Winter[a]	39	8	4.88:1
Dwarf × Nepal	48	13	3.69:1
Total	181	52	3.48:1

[a] In addition to the 39 normal and 8 dwarf plants, there were 5 winter plants which could not be classified.

[1] *Jour. Genetics*, 11:205-208, 1922.
[2] *Tidssk. Planteavl.*, 26:491-510, 1919.
[3] *Science*, Vol. LV, No. 1423, April 9, 1922.

TALKING DOGS

IN HIS article on "Prehistoric Telephone Days," that appeared in the National Geographic Magazine shortly before his death, Dr. Alexander Graham Bell mentioned his early efforts to teach dogs to talk. He received two letters about talking dogs from people who have been more successful, and they have an added interest at the present time. Perhaps someone will be inspired by these pioneer successes to develop a race of talking dogs by the selection of a strain with unusual linguistic ability. It has been suggested that the development of a race of unusually appreciative owners would also be necessary.

Anyone who has owned an intelligent dog or horse knows that man's best animal friends all but talk. They can express a great variety of emotions and ideas without the use of spoken words, so that it is but a step to the use of the more convenient method of vocal expression. EDITOR.

Toronto, Canada,
May 17, 1922.

My dear Dr. Bell,

A few days ago a copy of "The National Geographic Magazine" was sent to me by some friends in Ottawa, who, having read the paragraph on teaching a dog to speak from your article "Prehistoric Telephone Days," were very anxious that I should write and tell you about a rather extraordinary dog of mine.

He is a black Spaniel, which I rescued one day some seven years ago, and ever since he has looked upon me as his special property and charge.

As he is extremely fond of anything to eat, he always made the most terrific noises in his throat when sitting up to beg, keeping this up until he got what he wanted. Then one day, so clearly that everyone in the room recognized it, he made a sound which distinctly was, "Jus' a crumb," rolling the "r" in the crumb like a perfect little Frenchman. His name just happens to be "Noieand."

We all made a tremendous fuss over him, gave him what he wanted, then offered him something else to see if he could do it again. He carried on in this way for about two months, sometimes he would say it and sometimes he wouldn't, but whenever he did he got his "Crumb," likewise a great deal of fussing and petting.

At the end of about two months he began to realize, that this noise brought him whatever he wanted, and of his own accord would come running out the room, sit up on his little hind legs and say "Jus' a Crumb" over and over again, sometimes if he were excited, adding "a crumb, a crumb" at the end. He did this the first time when we gave him some maple syrup on bread, he thought he was just getting plain bread, and when he tasted the maple syrup, swallowed it whole jumped up on his hind legs and positively screamed "Jus' a Crumb, a crumb, a crumb, a crumb, a crumb," four times.

Very often in the afternoon, after the tea things have been carried out of the dining-room, we hear the little speech being made, and looking into the room, we see him sitting with his nose just on a level and about three inches removed from the second shelf of the curate talking away in the hope that someone will give him a crumb. He is really very honorable and would never touch anything as was proved on one occasion when he was shut up in a room for two hours with a plate which had three little cakes on it and which someone had left on a chair just the height of his nose. He was lying down beside the chair when I went in, but as soon as he saw me, jumped up and started saying what he wanted.

We notice that when he makes the noises which form this phrase, he rolls his tongue up over his nose, and the further up he rolls it the more distinct the words.

My Aunt, "Marshall Saunders," the author of "Beautiful Joe," who is of

course a great lover of animals and has studied them all her life, was told of this and believed it in a sort of way, but allowed rather a lot for our imaginations. In one of her later books she brings it in, but as soon as I read it, I knew she didn't realize just how phenomenal it was, so we insisted that she come and visit us as soon as possible.

When she did she was absolutely dumb-founded, and could hardly believe that it was Noieand who said it.

On different occasions also, when father brought out-of-town men home to dinner, their amazement has been quite funny to watch, unfortunately for them, they go home telling of this talking dog and as one poor man from the west told father, "Liar" was mild to what they called him, and it has been suggested that I ought to take my dog and make a tour of the West to redeem reputations lost on his account. As for myself, I have learned never to tell the story unless my old dog is with me. It is only after reading your article that I have the courage to tell you, but having read it, I feel that you will realize such a thing is possible, and I should so like if ever you are in Ottawa, where I live, (I am just in Toronto during the school terms) to have you come and see my dog. You can always find out where I am, or rather where Noieand is, from father, who is the Deputy Minister of Finance, anyone could direct you to his office, and I know if he thought you were interested, he would be only too pleased to have you see Noieand as he is just as proud of him as I am.

I do very much hope that sometime soon you will have occasion to visit Ottawa, I am

Yours very sincerely,
LAURA M. SAUNDERS.

Indianapolis, Indiana,
March 16, 1922.

Mr. Alexander Graham Bell,
1331 Connecticut Ave.,
Washington, D. C.
Dear Sir:—

I was very much interested in reading your article which appeared on page 34 of the Indianapolis Sunday Star, Mar. 12, 1922, concerning your efforts to teach a dog to talk.

My reason for writing you is to tell you that we have a female Boston Terrier now past six years old, that for about the last three years or more, has been saying a few words. This dog answers to the name of "Smarty." Without any assistance, other than being spoken to, she can plainly and distinctly utter the word "Now"; sometimes repeating it, in answer to the question, "When do you want it," and saying, "Now-now," or "Now-now-now." Without much imagination, you can understand that she tries to say, "I want it now," "I want to go," and "Want corn."

She is unusually fond of corn-crisp or cracker-jack, which we tell her is corn. The word "Corn" is the most difficult for her of any she attempts to utter. She makes a very wonderful effort, however, by opening her mouth very wide as in a yawn, and expelling the sound at the same time.

We also have a French Poodle, and sometimes when "Smarty" is playing with this dog and becomes vexed with it, or sometimes when playing with a ball that happens to roll under any article of furniture, she will talk voluntarily to herself and say, "Now-now."

She is very fond of taking a walk in the evening, and has a few times when very anxious to go on one of these trips, uttered intelligently the words, "Go walk."

Trusting the above may be of some interest and pleasure to you and also that I may hear from you when convenient concerning same, I am

Yours very respectfully,
EMERSON BROCK.

Indianapolis, Indiana.
May 12, 1922.

Mr. Alexander Graham Bell,
1331 Connecticut Ave.,
Washington, D. C.
Dear Sir:—

Received your communication of March 23rd, in reply to my letter of March 16th, in which I told you of the

Boston Terrier dog and her utterance of a few words, without any assistance whatever.

As to any further explanation of how she came to utter the words which she does, believe it has been occasioned solely by her close association with myself and wife in the home from the time she was born, and also by the repeated coaching and constant repetition of us talking to her and urging her to say these words and at the same time encouraging her and telling her she could say it.

At the present time, she has gotten so that she will often attempt to say, purely of her own accord, without any coaching or speaking to whatever, "I want corn," and "I want it now," Also frequently when asked if she should like to take a walk of an evening, she makes a remarkable effort to say "I want to walk," or "Want to go."

Am merely telling you these things about her because you are interested in the matter, and not for any purpose of advertising the dog in any way whatever. As we would not think of selling her at all.

Am enclosing herewith a couple of kodak pictures which will give you a good idea of the actual appearance of the dog.

Yours very truly,

EMERSON BROCK.

A New Social Case-History Manual

The California Bureau of Juvenile Research, at the Whittier State School, which has been doing such increasingly useful work in sociological and psychological investigations since its development from a single survey in 1914, has issued a "Social Case History Manual" describing the methods now in use by the Bureau for studying individuals and families. The outline also serves as a guide for the training of social workers.

A good deal of highly significant work in social problems has been done at the Whittier School under the guidance of its Superintendent, Fred C. Nelles, and J. Harold Williams as Director, assisted by an able staff, and the methods developed through practice and study are very adequately and compactly presented in the manual referred to, which will be found a very useful part of the literature of social research workers.

VALUE OF THE HEMP PLANT FOR INVESTIGATING SEX INHERITANCE[1]

The Genus Cannabis Offers a Promising Field for Studying Sex Inheritance in Plants

WALTER SCOTT MALLOCH
University of Illinois, Urbana, Ill.

IN 1920 Professor E. B. Babcock called the attention of the genetic world to the need of corroborative evidence in establishing the far reaching conclusions presented by the Drosophila workers.[2] In discussing the desiderata of ideal material for genetic investigation the contrast between plant and animal life was pointed out. The merits and demerits of the genus Crepis were enumerated as an illustration of a favorable plant which could be used as a means of substantiating the chromosome theory of heredity. Having had the pleasure of observing Crepis under test both cytologically and genetically for several years at the University of California, the writer is in full accord with the statements made as to the promise and value of Crepis for genetic investigations.

Nevertheless, Crepis and most of our plants cannot be used to substantiate the manner of sex inheritance. The inheritance of sex in plants has been studied in Bryonia by Correns[3] and in Lychnis by Shull.[4] It is the purpose of this article to present certain observations in connection with the habits of *Cannabis sativa* (hemp) and to call attention to the merits of this plant as one particularly adapted for the investigation of sex inheritance.

Hemp is commercially valuable both for its fiber and for a drug, *Cannabis indica* or *hashish*, Scientific investigations in hemp are thus worthy of support from agricultural institutions, from the commercial as well as from the scientific standpoint.

The genus Cannabis consists of a single species and belongs to the family Moraceae.[5] It is advantageous in genetic investigations to choose a genus having two or more species with the same chromosome number. In such cases one can compare the loci of the genes for similar characters in the two species upon the chromosome map. However, Humulus (hops) is a closely related taxonomic genus which may afford a basis for comparison. Cannabis has 10 haploid chromosomes while Humulus has 20.[6] This relationship has advantages as well as drawbacks but it is not prohibitive of certain comparative studies. The linear order of the genes in equivalent chromosomes cannot be compared but one may study the effect that the doubling of the chromosome number has upon

[1] A contribution from the Agronomy Plant Breeding Division, University of Illinois.
[2] BABCOCK, E. B. Crepis, A Promising Genus for Genetic Investigation. *American Naturalist* LIV: 270–276. 1920.
[3] BABCOCK AND CLAUSEN, *Genetics in Relation to Agriculture.* McGraw-Hill Book Company Inc. 1918.
[4] SHULL, G. H. Sex Limited Inheritance in *Lychnis dioica. Zeit. Abst. Vererb.* XII.
[5] KRAEMER, H. *Applied and Economic Botany.* p. 513.
- BAILEY, L. H. *Standard Cyclopedia of Horticulture.* p. 567. Macmillan and Co. New York. 1914.
[6] ISHIKAWA, M. A. A list of the Number of Chromosomes. *Bot. Mag. Tokyo* 30: 420–448. 1916.

GROWTH CONTROLLED BY SIZE OF POT

FIGURE 16. Two plants of the variety Kymington grown under identical conditions except that one was in a four-gallon, the other in an eight-gallon pot. Although the rate of growth is directly dependent on the size of the pot, the time required for the plants to flower is practically the same in all cases.

BRANCH OF A FEMALE PLANT

FIGURE 17. The genus, Cannabis, to which hemp belongs consists of a single species. It belongs to the Mulberry family and hops is the nearest related genus. This is a disadvantage, genetically, as it is desirable to have two rather closely related species, having the same chromosome number.

the distribution of characters in the chromosome groups. The chromosome number in Cannabis is somewhat larger than in *Drosophila melanogaster* and *Crepis virens* but it has the same number as *Zea maize* (corn). A low chromosome number facilitates the isolation of linkage groups but a high chromosome number does not prevent the discovery of linkage relationships. Woodworth[7] has isolated four linkage groups in *Soja max* which has about 20 haploid chromosomes, and at least 6 linkage groups have been found in corn. It would appear, then, that it is possible to analyze and locate groups of factors corresponding to the different chromosomes where the haploid number is as high as ten.

Hemp is a dioecious plant reaching a height of eight to twelve feet under favorable environmental conditions. Their development under greenhouse conditions at Urbana, Illinois, was found to be definitely controlled by the size of the pots in which they were grown. Those in 8-gallon pots were from eight to ten feet in height, and averaged two to three feet taller than the plants grown in pots half that size. The taller plants were more robust than the smaller ones but all

[7] WOODWORTH, C. M. Inheritance Studies in Soybeans. I. Cotyledon, Seed-coat; Hilum, and Pubescence colors. *Genetics*, VI.

MALE AND FEMALE FLOWERS OF HEMP

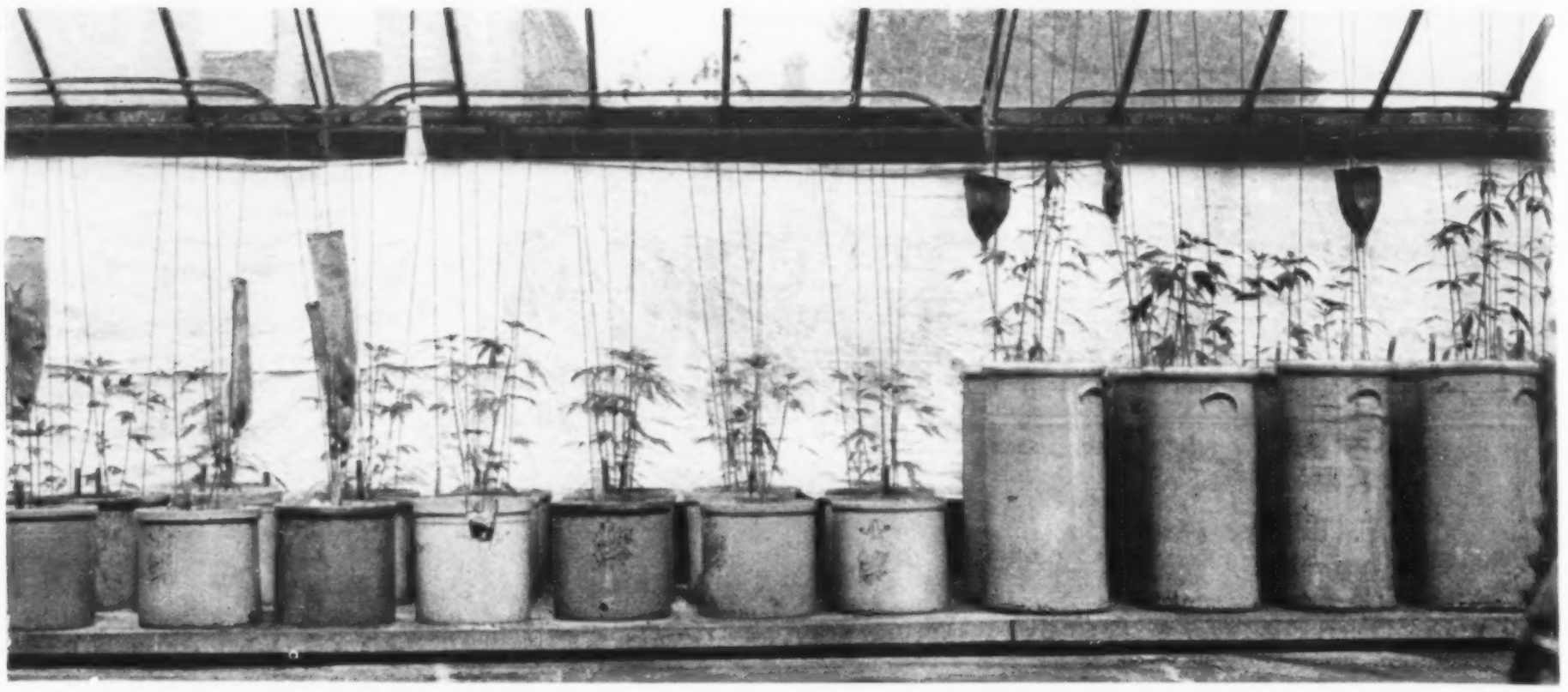
FIGURE 18. Pendent stamens can be seen in some of the male flowers (left), while the protruding stigmas are visible in nearly all of the female flowers.

The dioecism of hemp greatly simplifies the technique of experimental pollination, as it eliminates the necessity of emasculating the flowers. It is more difficult to establish genetically pure strains of a dioecious plant than of one that can be self-fertilized, and it is impossible to establish a pure line in the strict sense of the term.

fruited at about the same time. Seed sown during the fall and winter months produced shorter and more slender plants that fruited in a much less time than the summer plantings. Plants from seed sown in August, and those from seed sown in December both fruited in March.

These observations illustrate in a general way the influence of environmental conditions upon the growth of hemp. The lack of critical tests is recognized by the writer but the differences were very striking and were noticed at once by casual visitors not engaged in scientific investigations. The relationship between size of plant and size of jar is not of universal occurrence and is of considerable interest from this standpoint. While most plants show some reaction to the amount of space available for root development, they do not all respond so distinctly as hemp. This relationship would enable us to control the size of plant desired by regulating the amount of root space available. The plants in the greenhouse were easily grown, thrifty, vigorous, and free from destructive disease and insect enemies.

The dioecious nature of hemp is of considerable advantage in that it eliminates the labor involved in emasculation. This manipulation requires considerable time in certain plants like barley, but demands relatively little effort in other forms such as tobacco. In working with a dioecious plant one is at a disadvantage in



GENERAL VIEW OF GREENHOUSE CULTURE OF HEMP PLANTS

FIGURE 19. Even at this early stage some of the plants have begun to flower, but none set seed until a much later date. The female plants flower best at a temperature of 85° Fahrenheit, while the male plants produce flowers at a much lower temperature, about 60°. It is not absolutely necessary to have a greenhouse for experiments with hemp, as it grows well out of doors, but it is possible to raise two generations a year in the greenhouse.

attempting to establish homozygous strains. It is, of course, impossible to establish in hemp a pure line according to the strict definition given by Johannsen. There is no reason, however, why homozygous strains, similar to those in Drosophila cannot be established in the course of time. The long life-cycle of hemp is a serious drawback but this plant is no more undesirable in this respect than Zea and Nicotiana which have furnished the material for investigations leading to some of our most valuable genetic hypotheses. Since hemp is adapted to greenhouse conditions it has an advantage over corn, and it might be possible to obtain two generations a year by proper regulation of food and temperature conditions.

The staminate flowers occur in axillary panicles as illustrated in Figure 18. Hemp compares very favorably with corn in the quantity of pollen produced. A slightly disturbed male plant in full flower liberates a great shower of pollen sufficient to pollinate many female plants. This characteristic is of great value in hybridization because the same male parent can be used in a number of crosses.

The pistillate flowers are borne in short spikes, a single seed being produced by each flower. A cluster of female flowers is illustrated in Figure 18. The female plants branch considerably (Fig. 17) when grown under favorable environmental conditions and will produce over 1,000 seeds. The branching habit facilitates brother and sister mating as well as varietal crossing upon the same plant. The large number of seeds provides ample numbers for testing different genetic ratios. In order to hasten the production of female flowers the temperature should be kept around 85 degrees Fahrenheit. Male flowers are produced at a much lower temperature, averaging around 60 degrees Fahrenheit. At this temperature the male plants continue to flower for several months so that no difficulty is experienced in obtaining male and female flowers at the same time.

One of the desiderata of ideal genetic material is the facility with which one may hybridize different strains. The fruiting branch apparently does not flourish when enclosed in tight paper bags (Fig. 19) so it would appear that a closely woven cloth tent is desirable for this type of work. One meets a handicap here in securing sufficient funds for the purchase of such material. I have already called attention to the fact that hemp is a suitable greenhouse plant and thus a genetic investigation in hemp can be conducted both indoors and in the field where climatic conditions favor this procedure. In case

A SIMPLE-LEAVED MUTATION

FIGURE 20. Compare the simple leaves of this plant with the palmately cleft leaves shown in Figures 17 and 21.

This mutation appeared in a strain of the Ferramington variety. The leaflets of the normal digitate leaves appear to have grown together, as the normal number of midribs is present and the usual number of lobes. (See text, p. 282.)

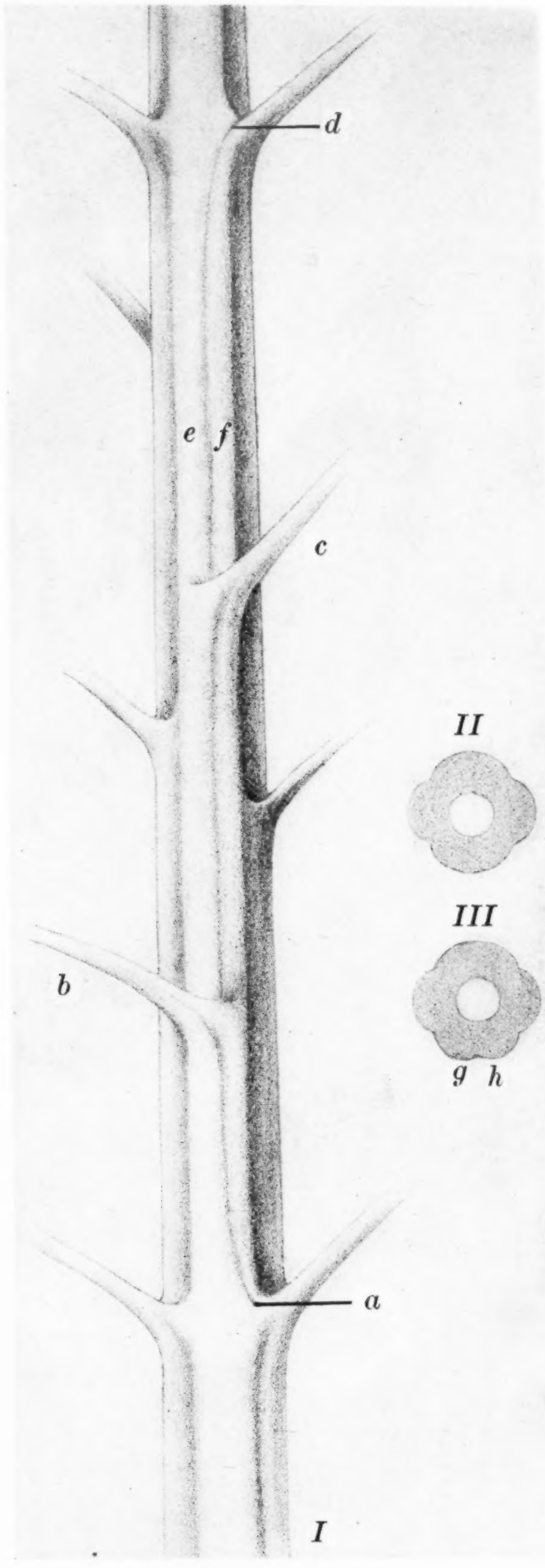
proper greenhouse facilities are not available, the investigation can be conducted entirely in the field without any greater loss of time than if plants like corn and tobacco were used. Sufficient cloth tents would be necessary both in the field and in the greenhouse. Genetic investigations with hemp are somewhat out of the question, then, unless sufficient funds are available.

"Variation is at once the hope and despair of the breeder," but a large number of sharply segregating characters are the hope and not the despair of the geneticist. Drosophila investigators have found that flies trapped in the open are largely of the normal wild form and that new characters are discovered through inbreeding and hybridization. The discovery of the present multiplicity of forms in *Zea maize* has been the result of careful observation and experimentation. In an obligatory cross-fertilized genus like Cannabis we would naturally

A SECTORIAL CHIMERA

FIGURE 21. A plant of the variety Tochigi was found in which several leaves were half green and half yellow. All these leaves were on the same side of the stem. Normally the stem has four ribs, as shown at II, Figure 22, but in the region of the chimera, one of the ribs was split and one half of the rib was green, the other yellow. (See text, p. 283.)

expect new forms to appear as a result of inbreeding. A mutant form was sent to the writer by Mr. L. H. Dewey of the United States Department of Agriculture and Professor A. H. Wright of the University of Wisconsin. This mutant is a simple leafed form which appeared in a strain of Ferramington. Instead of having the normal digitate leaf usually found in hemp, the mutant is characterized by a palmately cleft leaf as shown in Figure 20. The leaflets of the normal digitate leaf appear to have grown together as the normal number of midribs is present with an equal number of lobes. There is usually an unequal growth of tissue between the



STEM OF THE CHIMERA

FIGURE 22. a, d, beginning and end of divided rib; b, c, first and second chimera leaf; e, green half of rib; f, yellow half of rib; II, normal stem; III, stem in region of chimera; g, green rib; h, yellow rib.

midribs which results in excess leaf surface thus causing a folded and wavy appearance of the leaf.

The writer discovered a leaf and stem chimera in a male plant belonging to the variety Tochigi. The stem of hemp is four-angled with four distinct ribs. The lower leaves are opposite, a leaf arising from opposite ribs. On the particular plant under observation one of the four ribs was divided with a distinct depression between the divided strands for a distance including five series of leaves. The mutation arose in an intervening rib between two opposite leaves and ended in the same fashion (See Fig. 21). One-half of the divided rib was normal green while the other half was near "Martius Yellow."[8] Whenever a leaf arose from this divided rib, one half of the leaf and petiole was normal green, while the other half was "Martius Yellow." As hemp usually has an odd number of leaflets the middle leaflet was half green and half "Martius Yellow." The flowers arising on the normal side were of the normal type, while those arising on the abnormal side were "Martius Yellow" in color. The yellow flowers failed to open in this particular instance but were normal in all other respects.

This is clearly a sectorial chimera and further illustrates the possibility of obtaining new characters in hemp. Cannabis also exhibits differences in size characters and in seed coat shades.

Pritchard[9] and Schaffner[10] have shown that there is considerable variation in the sexual expression of hemp under certain environmental conditions. Pritchard obtained reversal of sex on both male and female plants by the removal of a certain number of flowers. Pritchard supports the hypotheses of Darwin and Strassburger in that both males and females are supposed to be potential hermaphrodites.

Schaffner observed teratological flowers and complete sexual reversal when the plants were grown on shallow benches in the greenhouse with low light intensity. This phenomenon was not found in my cultures due perhaps to better environmental conditions. Schaffner states that "sexuality is a state or condition not Mendelian in nature, but related to the functional activity of the plant and profoundly influenced by the environment." The statement is also made that "the ratio between carpellate and staminate individuals is about 1 : 1 with a large deviation in either direction for various plots." The equality of sexes was also found by the writer in the present observation. Unless some other plausible hypothesis can be offered to explain the equality of sexes, we are justified in accepting the Mendelian theory as the most probable basis for this phenomenon. The factor of nutrition can hardly furnish a mechanism for the equal distribution of sexes under normal environmental conditions.

The reversal of sex in hemp is an extremely interesting and important observation and it calls to mind the cases of the abnormal abdomen in Drosophila and the red flowered Primula. The cytologist has yet to determine what the germinal basis is for the sexual dimorphism exhibited by hemp and it remains for the geneticist to establish the genetic nature of this extreme range of character expression.

[8] Ridgway, R. *Color Standards and Nomenclature.* Published by the author, Washington, D. C. 1912.

[9] Pritchard, F. J. Change of Sex in Hemp. *Journal of Heredity* VII: 325–329. 1916.

[10] Schaffner, J. H. Influence of Environment on Sexual Expression in Hemp. *Botanical Gazette* XVII: 197–219. 1921.

A VARIATION IN THE DOWNING GOOSEBERRY

On a recent trip to northern Ohio my attention was called to certain gooseberry plants growing in a plantation of Downing. The general aspect of these plants and their fruit was not dissimilar to that of Downing but a closer examination revealed the difference in foliage shown in the illustration. The normal form has leaves nearly as broad as they are long, while the aberrant plants have long narrow leaves. This difference in foliage seems always to be associated with complete, or nearly complete barrenness. The owner thought that the plants changed from one form to the other, but his son was of the opinion that both forms existed in the nursery stock. The one theory suggests the possibility of an obscure disease in the nursery similar to the "reversion" of black currants described in English publications. The other brings in the possibility of a spurious strain or variety, possibly like the off-type lemon trees found by Shamel in his citrus work. PAUL THAYER.

ARE ANY SPECIES UNIFORM?

Or Should the Assumption of "Pure" Species be Discarded and Diversity Recognized as the Normal Evolutionary Condition?

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AN ADDRESS by Professor Bradley Moore Davis on "Species, Pure and Impure," published in Science for February 3, 1922, presents the case of "impure" species very effectively, while the "pure" species are treated only by definitions that lead, as Professor Davis says, to "what is almost an abstraction." That so little should be said of the "pure" species appears the more significant if we consider that species are not merely definitions or abstract assumptions, but natural groups of organic individuals, affording the veritable subject-matter of the biological sciences.

Species are maintained by processes of sexual reproduction, with continual crossing of the individual lines of descent, so that each species forms a network of lines of descent. The question of uniformity bears upon the nature of the specific network. Are there reasons for assuming that members of the same species are uniform, identical or homozygous? Or should we think of the members of species as normally diverse, with multifarious germinal constitutions represented among the different individuals and lines of descent that are woven together?

THE NETWORK OF DESCENT

The network of descent is not to be dismissed as an abstraction or mere figure of speech. Though more difficult to describe or to define by arbitrary standards, the species as a whole is not less real than the individual "lines" of descent that are followed in genetic or genealogical studies. It is usual to deal with separately propagated lines in the study of inheritance of particular characters, or for agricultural purposes, but an individual line of descent does not constitute a species. We get only partial views of heredity and evolution if the coherent, reticular constitution of species, the normal condition of crossing and weaving together of the different individual lines of descent, is left out of account. Our understanding of species governs inevitably our interpretation of the nature and causes of evolution. To think clearly about evolution is essential to constructive investigation, as well as to the development of practical applications of biology.

There would seem to be no doubt of the existence of diverse, heterozygous, or "impure," species, as Professor Davis calls them. The doubt is whether there are any "pure," uniform, species, or any tangible reasons for maintaining the assumption of uniform species, if not supported by facts. Examples of identical germinal constitutions are found in twins and in plants propagated by cuttings or by self-fertilization, but these do not constitute species. Some investigators have believed in "pure lines" that would remain constant, but "mutations" continue to appear in self-fertilized or line-bred stocks. Even with vegetative propagation, definite differences arise through the "bud mutations" that are now known to occur in many plants. Mutation in parthenogenetic generations of aphids has also been announced recently.[1]

For purposes of description, species are supposed to be uniform, but taxonomic ideals of uniformity, however useful in the study of classification, should not be allowed to bring confusion into evolutionary ideas. The ob-

[1] Baker, A. C. *Journ. Washington Academy of Sciences*, 12:320.

jects and methods of taxonomy are entirely different from those of evolutionary and genetic study. Though taxonomists disregard individual diversities and seek for the most constant or general characters, the difficulty of finding definitely diagnostic differences is well known, and is a testimony that diversity is a normal and universal condition of species.

DIVERSITY UNIVERSALLY FOUND

Close and careful observation of any natural species shows not merely infinitesimal diversity, but appreciable heritable differences. The art of breeding improved varieties is based on the recognition of differences. Skill and practice may be necessary to detect differences readily in unfamiliar species, but persistent search is always rewarded. The diversity of the human species is our most familiar example. Other species appear more uniform because less familiar, but shepherds know their individual sheep, and garden experts see individual differences in plants. Many travellers have noted their first impression that native Africans, Malays, or Chinese, were all alike, and their later surprise in finding the same people as different individually as Europeans. The framing of definite race characters is as difficult as writing satisfactory diagnoses of species.

An ideal taxonomic character is one that is shared by all the members of a species, and is not shared by any other species. Such a character must have arisen in the species and become established through the whole network of descent. On the other hand, large numbers of hereditary differences exist as forms of diversity, without becoming standardized or established as uniform diagnostic characters of species, but continuing to appear as parallel variations in many related species, or even in distinct genera. Thus many species or genera may respond in the same way to natural selection as a standardizing agency, if any change of the environment gives a more definite survival value to a particular character or combination of characters already represented in the networks of descent. Cases of parallel development may be taken to prove that evolution is mechanically directed, but less confidence is placed in the theory of orthogenesis when account is taken of the frequency of parallel variations.

THE EXISTENCE OF UNIFORM SPECIES UNPROVED

To "prove" that no species is uniform, or "pure," is beyond the logical range, like other universal negatives. Though diversities have been found in thousands of species, there are thousands more that have not been inspected for diversity or bred artificially to see whether they are heterozygous or not. The custom of many writers is to treat differences as variations and assume environmental causes. Or genetic diversity may be recognized but confused with hybridism. Tendencies to vary may be admitted, but uniformity claimed as a result of natural selection. According to a recent paper by Professor Osborn, " . . . Nature is constantly standardizing her machines through individual competition and producing flocks of birds and shoals of fishes which are so precisely alike that animals of the same age, sex, environment and heredity *show no perceptible variation* . . . " Thus the pure species assumption is carefully preserved, notwithstanding the confusion that it brings into general evolutionary ideas. Selection would need to be effective in rejecting all forms of diversity, if it were to keep the members of species "precisely alike." But why should we invoke natural selection or any other agency to explain a condition of uniformity that probably does not exist, and certainly has not been demonstrated?

Evolution no doubt is controlled by natural selection, to the extent that the adaptive characters may be favored by restricting the non-adaptive, but the special Darwinian doctrine of natural selection as the cause and explanation

of evolution is largely discredited. Changes are not confined to useful characters. Many useless, non-adaptive differences are developed, and useful features are specialized beyond the point of utility. Even serious defects are transmitted in latent form, out of reach of natural selection, but adding to the complexity of descent. A tendency to spontaneous variation must be assumed, even in cases where characters are increased under artificial selection, as recognized by Castle.[2]

With a belief in normal uniformity accepted, it is logical to argue that changes in the characters of species must require external agencies of the environment or internal "mechanisms of heredity," and such external or internal "causes of evolution" continue to be sought by many investigators. A different conception of evolution, requiring no such assumptions of special causes or mechanisms, becomes possible when the diversity that seems everywhere to exist among the members of species is reckoned as a normal condition of heredity, and of evolutionary progress.[3]

THE EVOLUTION OF SPECIES

In order to think clearly and effectively about evolution we must form practical conceptions of the changes that go on in species, as representing the evolutionary process. Species do not differ as mutations or pure lines differ, but in more general and less definite ways, on account of individual diversity. Evolution is to be thought of not merely as change of individual characters, or of characters of individual lines of descent, but as change in characters of species, modifying eventually the whole network of descent so that the members of a species can be recognized as distinct from members of the nearest related species. When this stage has been reached, an evolution of "new" species has been accomplished, by a process as gradual and indefinite but no less real than the development of a "new" language.

As a new word does not make a new language, so new characters do not constitute new species, unless the characters are preserved and established in networks of descent. Many writers go astray in assuming that evolution is merely originating new characters, or is some special form of character-origination, so that many scientific works do not convey a clear conception of the evolutionary process. Professor Bateson recently has misled Mr. Bryan into supposing that evolution is discredited in the scientific world. The mistake has arisen because both are looking for something that probably never occurs, and should not be expected to occur, a sudden transformation of one species into another. Darwin carefully considered and definitely rejected the idea of species originating abruptly, and this judgment rests as more firmly established by the efforts that have been made to displace it.

It is not in the nature of species as networks of descent to originate by definite, sudden changes of characters, just as it is not in the nature of languages to be formed or changed suddenly. The Latin language was not abruptly discarded or displaced in Italy, Spain, or France, but local forms of Latin developed gradually, and eventually were recognized as distinct languages. Mule-bred languages have been elaborated and "new plant creations" have been produced and propagated artificially, but such devices are in contrast with normal development. Diversity in words and forms of expression is universal in languages, like diversity of characters in species, and the relation of diversity to progress, in furnishing the material of continued evolutionary change, is a further analogy.

[2] *Journal of the Washington Academy of Sciences*, 7:387, June 19, 1917.

[3] Evolution not the Origin of Species, *Popular Science Monthly*, March 1904; The Nature of Evolution, *Science*, N. S., Sept. 7, 1906; Methods and Causes of Evolution, *Bul. 136*, Bureau of Plant Industry, October 1908; Pure Strains as Artifacts of Breeding, *The American Naturalist*, April 1909.

A EUGENIC COROLLARY

The most powerful educative agents of the vegetative apparatus of a human being are the other human beings around him, and they comprise the most powerful of the external effectors of education, for better, for worse. The training and education of the endocrine-vegetative system is the basis of all social rules (Habit, Custom, Law, Conscience). An unresolved discord, a continued conflict among the parts of the vegetative system, in spite of such education, is the foundation of the unhappiness of the acute and chronic misfits and maladjusted, the neurotic and the psychotic.

(LOUIS BERMAN, M.D., *the Glands Regulating personality*, p. 194)

Children Need Fathers

Is there any success that can pay a father for not knowing his child? If no amount of success could repay the child for neglect on the part of the mother, how much can make up for neglect on the part of the father? I have been teaching young men and women of college age for ten years and I am convinced that the greatest need of American children to-day is greater care from their fathers, greater feeling of responsibility for the upbringing of the children on the part of the fathers. A child needs a father's guidance just as much as a mother's. It is not a question of a mother's shielding the father and watching over the children while the father—free to forget them—makes name and fame. No. The best in both the father and mother should go into the care of the children. Then let him who can, make a career for himself "with equal rights for all and special privileges for none."

LOUISE DUDLEY, *The Atlantic Monthly*, June, 1922.

The Development of the Child

THE PHYSICAL GROWTH OF CHILDREN FROM BIRTH TO MATURITY, by Bird T. Baldwin. University of Iowa Studies in Child Welfare, Vol. I, No. 1, pp. 411, pub. by the University, Iowa City, 1921.

Here, in concise form, is a mass of well-digested material which must serve as a work of reference for all who are interested in the question, "How does a child grow?" The original data cover thousands of children; a series of easily compared tables gives certain facts about more than five million others; while an annotated bibliography of 911 titles puts the reader in touch with other authorities. The concepts of anatomical age and physiological age are developed in an interesting way. Little material bearing directly on problems of heredity is presented, but it is announced that special studies, covering all the members of certain families, are being made which will illustrate the parent-offspring correlation. The fraternal correlation is dealt with in this volume particularly in the cases of twins.—P.P.